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3 October 1958

Volume 128, Number 3327

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Thorstein Veblen...on the place of science

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—*The Place of Science in Modern Civilization, 1906*

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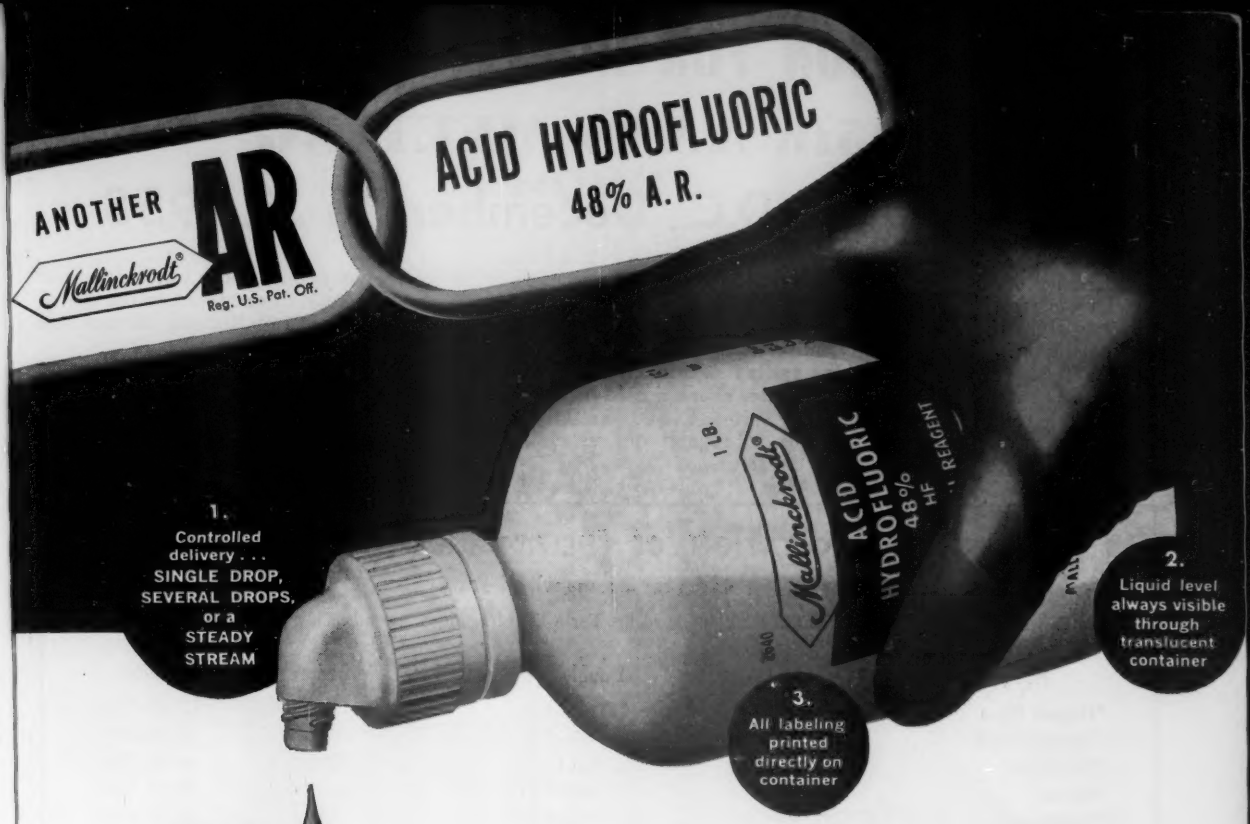

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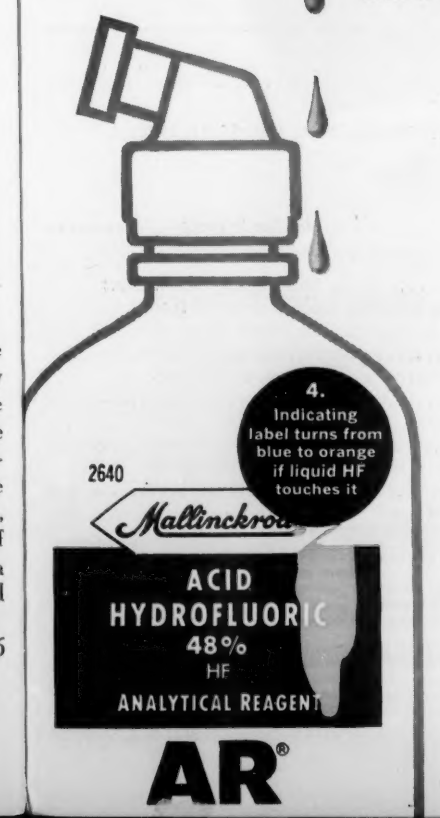

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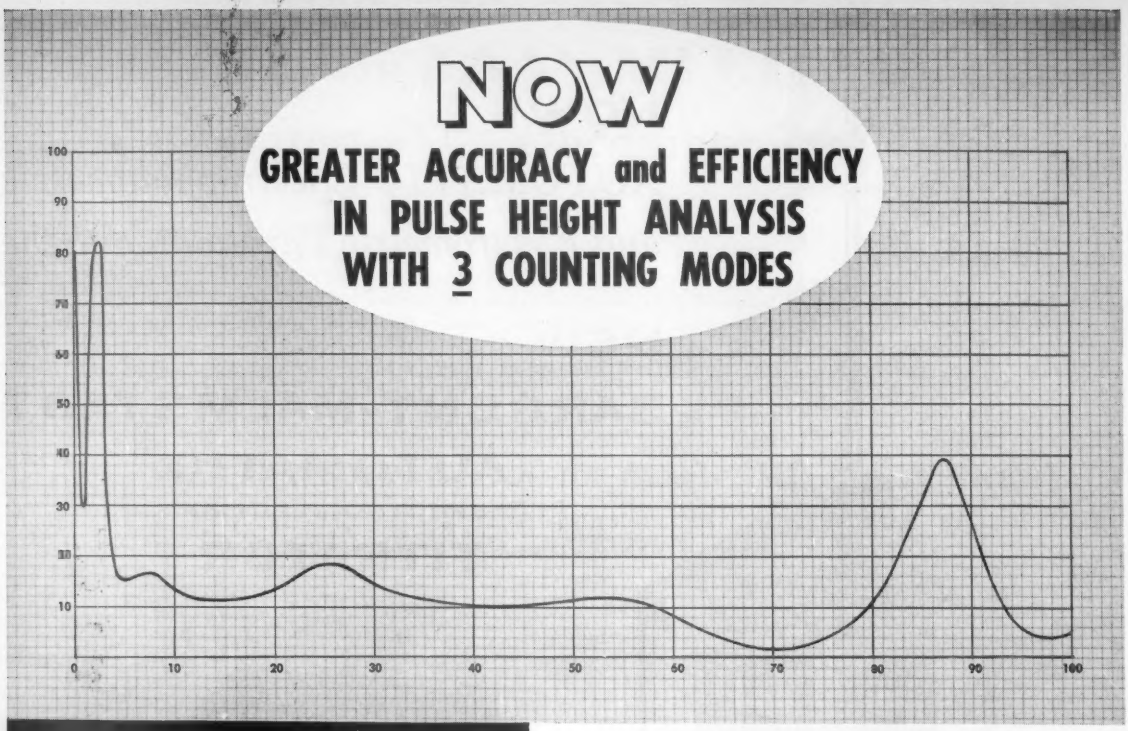

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SCIENCE, which is now combined with THE SCIENTIFIC MONTHLY, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. The joint journal is published in the SCIENCE format. Entered at the Lancaster, Pa., Post Office as second class matter under the Act of 3 March 1879. SCIENCE is indexed in the *Reader's Guide to Periodical Literature*.

Editorial and personnel-placement correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. For detailed suggestions on the preparation of manuscripts, book reviews, and illustrations, see *Science* 125, 16 (4 Jan. 1957).

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The Lost Legion

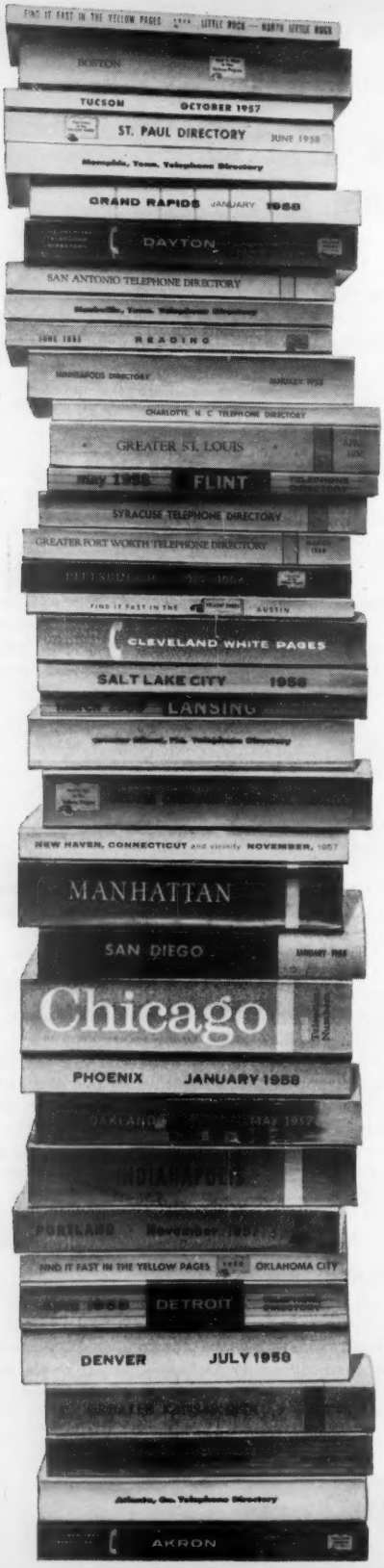
In recent years a shift in the locus of research has taken place. "Research done in industrial laboratories is now the major portion of research in progress in this country and is increasing steadily" [*Am. Scientist* **46**, 24 (1958)]. In industrial laboratories, and to a lesser extent in research enterprises conducted under university and institute auspices, the team has replaced the individual investigator. The scientist working alone and the majority of those who engage in contract work in universities expect to publish their results. This condition does not prevail to a marked degree in industrial laboratories, where teams of scientists and technicians work on projects that are designed to have commercial value to their employers. Many scientists who enter industrial employment constitute a lost legion so far as publication of research results is concerned.

A young scientist whose only experience has been in the university environment may be unaware of conditions that will limit his professional advancement if he accepts employment in one of the 4834 industrial laboratories listed by the National Research Council. After a period of orientation it is likely that he will become a member of a research team that may or may not be working in the area of his special interest. The research team is primarily a group of specialists working under the supervision of an administrator. It is essentially a managerial control device whose success, from the commercial point of view, has been notable. Industrialists hold the concept of team management in high regard. Howard Joseph Morgens, president of the Procter & Gamble Company, has been quoted as saying, "We all work so closely together that you can't say one man did one thing and another something else" [*Fortune* **56**, 160 (Nov. 1957)].

But consider the effect of team membership upon the professional career of a participating scientist. His superiors will determine the direction of the research and may subdivide the work and shift team members in and out of the group until all record of individual contribution is hopelessly lost. A man may spend years working diligently in an industrial laboratory and have no published record of his research. Later, if he chooses to seek employment elsewhere or is considered for a university appointment, he is unable to present evidence of his status as a productive scientist. He is unknown to his contemporaries outside the small group of fellow workers in his employer's laboratory.

How can the individual scientist protect himself from the tyranny of "team management"? He can choose a university career and work where the right to publish is safeguarded by university policy or contract. But if he genuinely wants the advantages offered by industrial employment—and there are advantages, financial and otherwise—he first should get the facts regarding the publication policy of the company that he is considering. Before accepting employment he should obtain a statement in writing that will protect his rights as a scientist. Otherwise he will find himself at the mercy of those managers who happen to occupy high-level posts at a given time.

A discussion of the conditions of employment and a written agreement about the salient points will be of advantage to the scientist and to the employer. The rights of the former will be recognized, and the latter will discover that the supply of outstanding men seeking industrial employment will increase. As it is now, many university professors hesitate to encourage their ablest students to enter an area where they would be enrolled in the lost legion—RICHARD S. UHRBROCK, *Ohio University, Athens.*



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CURRENT PROBLEMS IN RESEARCH

Trends in Climatology

The investigation of climates is moving from a descriptive science to a science grounded in physics.

H. E. Landsberg

The aim of climatology is to abstract from the varied and rapidly changing weather phenomena the underlying patterns that characterize the atmospheric environment for regions of the earth and for the earth as a whole. In recent decades climatology has gradually evolved from a purely descriptive science to a science that is grounded in physics. But climatology is not confined to the study of large-scale climatic events alone; it is also, for example, concerned with microclimates and with the influence of climatic factors on the life processes of plants and animals. The field is so broad that it is impossible to treat more than a limited number of topics in a single article; accordingly, I have selected certain topics for discussion but at the same time have tried to present a general view of climatology.

History

The problems in this field are difficult because of the many different ingredients—in complex spatial and temporal interrelations—which make up a climate. The major factors affecting climate are the sun (the primary source of energy), the position of the earth in the solar system, and the inclination of the earth's axis with respect to its orbit. That these are the most important factors in causing differences in climate was recognized even by some early Greek scientists, probably first by Eratosthenes. The Greeks defined climate according to the mean inclination of the sun's rays with respect to the terrestrial horizontal. Thus temperature zones according to latitude were distinguished. This gave rise to an organization of climatic facts into a causally related scheme of *torrid, temperate,* and *frigid* zones, albeit somewhat anthropocentric in scope.

Little was added to this concept for over 1800 years. But then, one by one, the complicating factors and their influence became obvious. On a large scale, these were the distribution of land and ocean on earth and the existence of larger and smaller mountains. The local influences of lakes, forests, and vegetation-covered and bare soil also became recognized. In the atmosphere itself one of the controlling factors is that *bête-noire* of the meteorologist, the water. Its presence in all states of aggregation—vapor, liquid, solid—often the three of them simultaneously, and quickly changing from one to another, complicates matters immensely. Through evaporation and condensation, cloudiness and precipitation, it governs much of the climate, as is discussed more specifically later.

Historically, significant advances in the study of climates were made after systematic measurements of atmospheric parameters began. Although such measurements started in some places in Europe in the 17th century, it was during the high surge of science in the second half of the 18th century that many learned men the world over became interested in the atmospheric environment. Physicians, astronomers, natural philosophers, and clergymen recorded the temperature, pressure, wind, precipitation, and weather conditions faithfully. There was considerable appreciation that knowledge about climate might be useful and broad speculation that climate had a notable influence on health. This last was a notion which had an early antecedent in Greece, in the theories of Hippocrates. Equipment and procedures, though primitive in the beginning, became gradually standardized.

The problem of standardization has remained with us for nearly two centuries because only with standardization can comparisons between simultaneous records at various localities or between earlier data and later readings become meaningful. Only in recent years has the World Meteorological Organization, one of the specialized agencies of the United Nations, shown a modicum of success in establishing uniform observation practices in all countries.

The interest in the atmospheric environment in the outgoing 18th century was quite universal among the well-educated. Thomas Jefferson (*1*) considered climatic observations important to "increase the progress of human knowledge." From data collected at Williamsburg, Virginia, in the years 1772 to 1777, he prepared one of the first climatic summaries for North America (Fig. 1). A cooperative venture of sizable proportions was initiated by the Societas Meteorologica Palatina with the Prince Elector Karl Theodor of the Palatinate as sponsor. Uniformly calibrated instruments and observing instructions were distributed to 35 academies and learned societies in the then readily accessible parts of the world. Data were collected and published in detail (*2*). These data became the raw material for the first comparative climatological studies. Twelve annual volumes appeared before this pioneering survey ceased in the turmoil of revolu-

The author is director of the Office of Climatology, U.S. Weather Bureau, Washington, D.C.

	Fall of rain, &c. in inches	Least and greatest daily heat by Farenheit's thermometer.		WINDS.								
				N.	N.E.	E.	S.E.	S.	SW.	W.	NW.	Total.
January.	3.192	38½	to 44	73	47	32	10	11	78	40	46	337
Feb.	2.049	41	47½	61	52	24	11	4	63	30	31	276
March.	3.95	48	54½	49	44	38	28	14	83	29	33	318
April.	3.68	56	62½	35	44	54	19	9	58	18	20	257
May.	2.871	63	70½	27	36	62	23	7	74	32	20	281
June.	3.751	71½	78¼	22	34	43	24	13	81	25	25	267
July.	4.497	77	82½	41	44	75	15	7	95	32	19	328
August.	9.153	76¼	81	43	52	40	30	9	103	27	30	334
Sept.	4.761	69½	74¼	70	60	51	18	10	81	18	37	345
Oct.	3.633	61¼	66½	52	77	64	15	6	56	23	34	327
Nov.	2.617	47¾	53½	74	21	20	14	9	63	35	58	294
Dec.	2.877	43	48¾	64	37	18	16	10	91	42	56	334
Total.	47.038	8 A. M.	4 P. M	611	548	521	223	109	926	351	409	3698

Fig. 1. Climatic table for Williamsburg, Va.; from Thomas Jefferson (*1*).

tions and wars of the outgoing 18th century.

However, the pattern was set. From a few score stations, climatological networks have been expanding. Including rainfall stations, there are presently probably about 150,000 land locations from which some climatological information is available. The rapid rise in stations is well marked in the United States (Fig. 2). The desirable end is not in sight because station density goes hand in hand with population density and many areas are void of settlements. Only since the start of the International Geophysical Year have we had systematic climatological information, for example, from the South Pole area. The uneven coverage of the land areas with observing posts is a handicap to climatological research. It is even worse over the oceans. There regular observations started in the 1850's. One of the principal movers to obtain weather data from the seas was the U.S. naval lieutenant Matthew F. Maury. Millions of individual readings have been gathered in the weather archives since, but they are bunched on the shipping lanes. There are vast ocean areas which are hardly ever crossed by a ship. From the Arctic sea, ice data are also scarce. We have no systematic measurement of rainfall over the ocean. Some data are accumulating from Texas Towers offshore, but a climatological survey of the oceans, perhaps by regularly spaced, anchored, automatic weather floats, is still a dream for the future (*3*).

Thus the climatologist is still struggling with the question, "What is there?" For this reason the answers to the usual second question in science—Why is it so?—are woefully incomplete.

Climatic Energetics

At the basis of all quantitative considerations in climatology are the questions of energy balance. Presently this starts with the assumption that income from solar radiation and loss of heat by the earth are equal. The income from the sun (the so-called solar constant) is known to be about 2 calories per square centimeter per minute at the boundary of the atmosphere, at the mean distance between earth and sun, normal to the incident rays. This over-all value is probably valid within 1 percent. However, in various spectral regions, especially in the short wavelengths, considerable fluctuations in intensity can occur. The total energy income and its spectral distribution are now amenable to direct measurements from satellites. This will be one of the most valuable contributions of these vehicles to climatology. Equally important will be essentially extra-atmospheric measurements of the earth's albedo, that is, the portion of the incoming energy directly lost to space by the planet through reflection from clouds, snow and ice surfaces (as primary contributors to the loss), and from land and ocean surfaces (as secondary reflectors). The over-all albedo of the earth has been estimated at 35 percent, but this value might be off by several percent either way. There are certainly considerable seasonal variations and, possibly, changes from year to year. Equally important for areal climates are the local values of albedo and the variations in different landscapes and seasons. These values govern how much heat is absorbed and becomes available for atmospheric energy transformations.

Quite unknown are the storage factors. There is certainly the possibility that heat energy beyond the yearly cycle is stored in the ocean. It may then be released again over a longer period of time, rather than be used immediately for driving the general circulation of the atmosphere. Even though this question of heat storage is open, attempts have been made to estimate the heat balance of the earth and of smaller portions of its surface. Various approaches have been used, most of them indirect. Among the direct approaches are the measurements of incoming and outgoing radiation to establish locally the radiation balance. This has been done at too few places as yet to furnish significant information for the global picture. However, net-radiometers which measure and integrate the radiation balance from day to day are becoming more common equipment at observing stations. The other components of the total heat budget—condensation-evaporation and advection—are difficult to observe directly. They are generally deduced from other climatic elements. The most comprehensive study in this connection has been carried on by Russian investigators (*4*). For the earth as a whole, and on an annual basis, they obtained the following figures (all in kilocalories per square centimeter per year): total radiation received, 129;

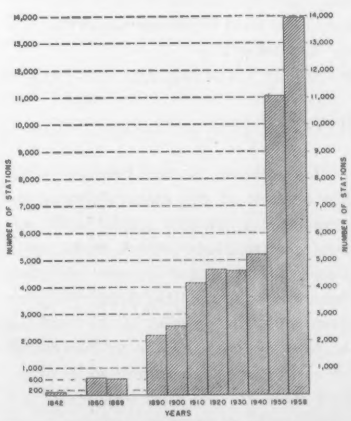

Fig. 2. Number of climatic observing stations in the United States and possessions, 1842–1958.

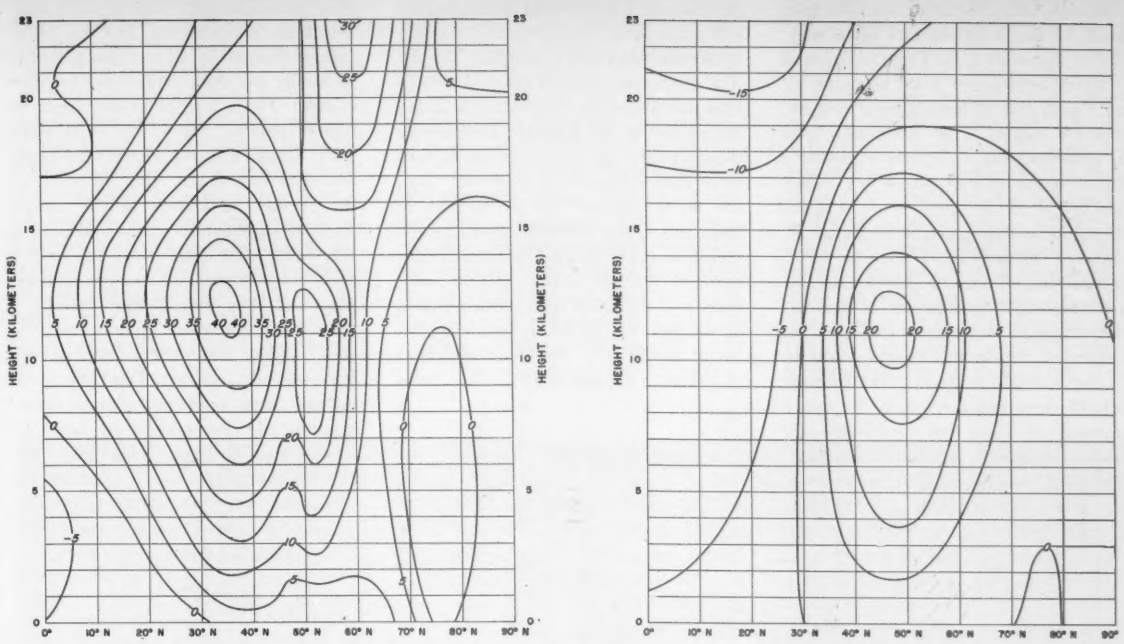

Fig. 3. Mean westerly component of the wind in meters per second in vertical section through the atmosphere along the 80th meridian west, based on ten years of observations (*38*). Negative values indicate prevailing easterly winds. Left section shows values for January, right section for July.

heat available for atmospheric transactions and motions after reflection and other direct losses, 68; lost by use in evaporation, 56; lost by turbulent transport, 12. The values for continents and oceans by individual latitudes are, of course, quite different from these means. The differences between the larger subdivisions of the globe are the cause of the general atmospheric circulation and its local manifestations. They cause the trade winds, the westerlies, the monsoons, and all the embedded eddies, such as ordinary cyclones and tropical storms. All of these currents, including the now famous atmospheric jet streams, are part of the energy-dissipating mechanism.

As already stated, the role of water in the atmosphere is of fundamental importance. It enters actively into all heat balance considerations. In a limited way this is due to the infrared absorption spectrum of water vapor. But the primary contribution comes about by evaporation (consuming heat) and condensation or freezing (liberating heat). The vapor phase is a means of transporting latent heat from one place to another. Last but not least, water plays a passive role in heat transactions because, as clouds and surface snow or ice, it reflects large amounts of incoming shortwave radiation from the sun. Next to air temperature, it is also the element which has the greatest influence on plants, animals, and human activities. In the form of rain or snow it governs water supplies; in the form of hail it causes crop damage. Its lack spells desert conditions or temporary drought for afflicted areas. Even as fine droplets in clouds or fog it affects life processes and recreation or traffic on land, sea, and in the air.

The water cycle from the ocean through the air to rivers, streams, and underground storage in its relation to the general atmospheric circulation has become fairly well known in broad outline and is reflected on the climatic charts. But as a process of atmospheric energetics, understanding has barely begun. Considerable effort has been expended on the problem of evapotranspiration (*5*). This concerns the water losses from land surfaces. Evaporation from open water surfaces in terms of the atmospheric environment has at least yielded to empirical approaches, but the water losses from bare and plant-covered soil can as yet be ascertained only in rough approximation. Locally it can be calculated as a function of the heat flux and the turbulent transfer of mass. Such losses, together with the gains by rainfall, can be entered into a bookkeeping system which indicates an approximation of available soil moisture. This factor is important in farm management and irrigation planning. The climatology of the moisture balance has become one of the most important factors in agricultural land utilization. It is likely to stay in the foreground of interest because of the world food problems engendered by population pressures.

It is fortunate that theoretical schemes which underlie much of present-day procedures for ascertaining the water cycle can now be supplemented by tracer techniques. These make use of isotope determinations. Both deuterium and tritium have recently been employed for this purpose (*6*). Interesting new facts have been added to our knowledge by these procedures. For example, the storage time of water in vapor form in the air ranges, on an average, from 3 to 10 days. In the central United States it also appears that the storage time of water lost to the soil by percolation is of an order of magnitude of several years. More work needs to be done with these techniques. Also, a wide geographical coverage is desirable. This new avenue of research will certainly supply quantitative answers to many of the questions related to atmospheric water transport.

The foregoing problem is one among many that make it clear that solutions in climatology can no longer be looked for or found by reference to surface ob-

servations alone. Great strides have been made in the collection and summarization of upper air data. These have found practical application in the planning for air routes and as basic design information for rockets. They have been used as guidelines for estimating radioactive fallout from various levels (*7*). They also give us better insight into the three-dimensional flow patterns of global air currents. Among them are the swift, meandering jet streams. The jet streams are a dynamic consequence of momentum transport into narrow zones of confluence of various air currents produced by the general circulation. The primary seat of these fast flows is in the upper troposphere, where they not infrequently exceed speeds of 200 miles per hour. The strongest jet streams are in the middle latitudes, but there are less pronounced and less steady currents of this type in the tropics and polar regions. It even appears that stratospheric jets are in existence. The main jet stream is quite noticeable even in atmospheric cross sections reflecting mean conditions (Fig. 3). The mean flow patterns are now reasonably well known for the Northern Hemisphere, but in the Southern Hemisphere data are still too sparse for more than local climatological analysis (*8*). Also, the fluctuations of the jet streams in time and space are still targets of exploration. As there are close associations between the jet stream and rainfall, studies of the more comprehensive data to be expected in the future will give better insight into the broad dynamics of global precipitation (*9*).

Climatic Classification

For several decades the problem of climatic classification has created lively discussions. More than a score of schemes for classifying climates have been proposed (*10*). None of them satisfies all the requirements. The basic difficulty is inherent in the fact that there exist hardly any sharp boundaries between climatic zones. Except at the crests of high mountains (Fig. 4) and at the coast lines, various climatic regimes gradually fade into each other. Also, the shifts of the general circulation of the atmosphere from season to season and year to year bring fixed localities on the surface of the earth sometimes into one climatic zone and then into another. Hence a strict taxonomy which separates natural entities is not possible. All dividing lines are essentially arbitrary. This is the more the case when, as in most climatic classifications, the class criteria are based on mean values of climatic elements. A climatological mean value is often only a very poor representation of conditions. The width of variation of atmospheric elements harbors often decisive factors. In addition, the choice of combination

Fig. 4. Major mountains act as great climatic divides. Usually their windward and lee slopes have radically different climatic conditions. Orographic cloud formations such as those shown are frequently very spectacular. They offer a primary hope of increasing precipitation by suitable seeding techniques. [U.S. Weather Bureau, by F. Ellerman]

of elements represented in the classification is usually dictated by a specific application rather than by inherent properties of the climate itself.

For geographical purposes, climatic classifications often have the boundaries of types essentially governed by other entities, such as plant cover associated with (or perhaps caused by) a specific combination of climatic conditions. Even that will not yield an unambiguous answer, because several combinations of climatic factors may have the same end result. The classical climatic classification schemes, which essentially arranged their limits to coincide with the major plant provinces on earth, have didactic value. They help in visualizing the global distribution within a readily comprehensible framework.

In many climatic classifications only temperature and precipitation are considered as climatic elements. Admittedly, these are most widely observed. They also generally affect human activities, particularly agriculture. However, there can be as many classifications with various combinations of elements as there are practical purposes. For air conditioning, one would choose suitable combinations of temperature, humidity, and air motion as classification elements. In that case the class limits would be comfort sensations. To classify airports or air routes in a climatic sense one has to consider the flying weather. The class limits are then determined by cloud ceilings, visibilities, turbulence, wind directions and speeds, and their respective joint frequencies. Essentially, one can arrive at a classification for every activity influenced by climate. To illustrate this point further: Very recently a classification has been devised for refractivity of the atmosphere as it affects radio wave transmission (*11*). This incorporates the pertinent elements of pressure, temperature, and humidity and their

Fig. 5. Climatic changes through the millenia are particularly notable in the arid and semiarid regions of the southwestern United States. At one time heavy rainfall and run-off helped in modeling outstanding features of the landscape such as those shown in the Grand Canyon of the Colorado. [U.S. Weather Bureau, by Madison Gilbert]

Table 1. Notation for climatic typing. Mixtures of two types are indicated in parentheses, as (*CA*), (*AE*). A further symbol employed is the subscript *e* to designate extreme conditions.

Feature	Symbol
Major circulation patterns (primary controls)	
Migrating cyclones	*C*
Quasi-stationary anticyclones	*A*
Equatorial convergence	*E*
Secondary or seasonal circulation features	
Typical monsoons	*S*
Predominant trade winds	*T*
Major surface influences	
Continental	*c*
Oceanic	*o*
Mountain	*m*
windward slope	*mw*
lee slope	*ml*
Glaciated	*g*

normal vertical and seasonal variations.

A purely qualitative scheme of climatic classification can be designed to avoid the multiplicity and the difficulty of fixed, yet arbitrary, numerical values. This classification stems from the broad meteorological aspects of climate and the basic factors of the general circulation. It is in line with attempts in recent years to get away from the static concept represented by mean values of climatic elements (*12*). After all, there is nothing fixed in the atmosphere, and even such abstractions from its unending motions as the climate should reflect the dynamics of the system. The classification procedure then is nothing but a descriptive symbolism or shorthand notation of major types. Table 1 shows such a notation system. In this notation the climate of western New York State would be designated as *Cc*, that of Ireland as *Co*, and that of North Dakota as Cc_e. The coast of California would be (*CA*)*o*; the Sahara, Ac_e; Bermuda, *Ao*; and Oahu, *ATo*. The central Amazon valley would be labeled *Ec* and the Gilbert Islands *Eo*. Among the mountain climates, the Cascades have *Cm*, the Australian Great Dividing Range has *Am*, and the Mount Kenya area, *Em*. The various combinations of symbols cover all macroclimates. However, they do not reflect the local influences, usually labeled meso- or microclimates, such as lake breezes, slope exposures, and vegetation conditions.

Climatic Changes

Another reason why classification, in fixed terms, is an ad hoc procedure, is inherent in the fluctuations of climate with respect to time. These climatic changes are among the most fascinating problems in climatology. Changes occur both in short and long intervals of time. The long intervals comprise geological epochs; the short ones, centuries and millenia (Fig. 5). There is little point in talking about *climatic* changes or fluctuations when only a few years or decades are under consideration. Usually the fluctuations in such limited intervals are difficult to distinguish from random variations, if indeed they are not such variations. Any cyclical—or better rhythmical—elements in the same decadal intervals, if any, are masked by "noise." There is some evidence of weak components of one half, one, two, and perhaps other multiples of the sunspot cycle in some series of climatic data, but their amplitude is small. Other rhythmical elements appear and then vanish again from climatic times series.

For a great many practical purposes the values in a climatic time series can be treated on probability premises as if they had occurred by chance. This makes it possible to use climatic data from the past with considerable confidence for purposes of future planning. Various risks can be assessed for engineering construction and design as well as agricultural use. The list of such applications is large and steadily growing. A few examples will suffice as illustration. Many structures have to be built with knowledge of extreme weather events to insure adequate safety: the maximum wind for a tower, hangar, or bridge; the highest snow load for a roof; the heaviest rain intensities for culvert design. The probabilities of various limits can be estimated from the observations by use of various extreme-value distributions (*13*). For heating or air conditioning plant capacity, the knowledge of normal and extreme loads is also essential. These, too, can be efficiently estimated from the statistical properties of the past climatic record. Statistical functions, such as the incomplete gamma distribution, have been successfully applied to weekly or monthly rainfall values. This approach yielded valuable planning information for agricultural purposes (*14*). Similar analyses for freeze dates have been of considerable practical value for crop practices.

Even if we can safely assume that for plans not exceeding a few decades the past climatic record can be taken as a guide to the future, this does not imply the absence of trends. As more data accumulate the evidence for measurable climatic changes multiplies. For nearly half a century a gradual warming of the Northern Hemisphere has been noted. Were we to rely on temperature readings alone, the data for many areas could be challenged. To be sure, a rise of several degrees Fahrenheit can be noted in many temperature series since 1900. Unfortunately, numerous weather observing stations have been shifted around, and their records are far from homogeneous. Moreover, many are in or near growing cities. Part of the rise of temperature

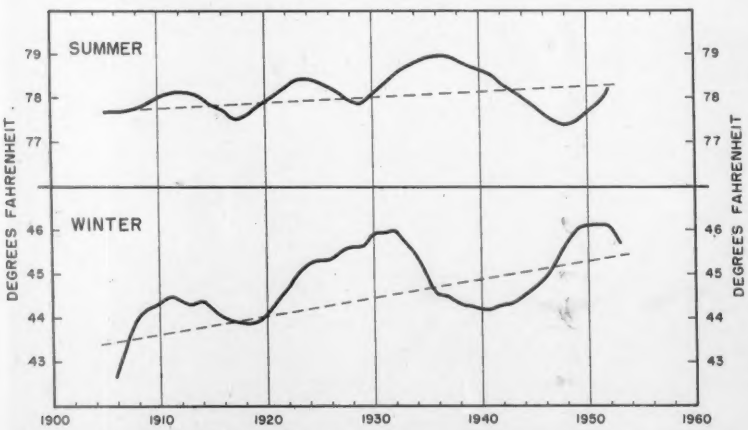

Fig. 6. Time series of seasonal mean temperatures at Winthrop College, South Carolina, one of the climatic reference stations (lat. 34°57′N, long. 81°03′W, elevation 690 ft). Summer comprises the months June-August, 1900–57; winter, December-February, 1900–58. Data have been smoothed by a normal-curve smoothing function of length $2\sigma = 5$ years. Values are plotted at the midpoint of the smoothing interval (*39*). Dashed lines show the general temperature trend of the region.

must be attributed to the large number of heat-producing factors of modern industrial communities. These factors, together with air pollution, have created a new man-made climate which has developed in parallel with any natural climatic changes over the same time period. It is hard to apportion what part of the temperature rise has been artificial and what portion natural. This difficulty will be minimized in the future by establishment and maintenance of climatic stations in isolated areas where man-made environmental changes will remain minimal. These will be called climatic reference or "bench-mark" stations (*15*). Fortunately, there exist now enough rural data and other evidence to give us some clues. For the moderate latitudes, 30° to 50°N, in the area around the Atlantic, the natural rise can be estimated at about 2°F per century. At higher latitudes the value may be about twice that amount. The rise has been particularly pronounced in the winter season (Fig. 6).

It is interesting to revert here for a moment to Jefferson's climatic table of Williamsburg. Even though we know little about the circumstances under which the observations were made, comparison with a recent time interval shows that no *radical* change of climate has taken place. Temperatures are now slightly higher than they were at the end of the 18th century. But it should be remembered that there was a marked temperature fall between the beginning and middle of the 19th century, which was followed by the rise of the 20th. Rainfall is still about the same. The winds seem to show now a few more southerly and less northerly components than in Jefferson's day.

The indirect evidence for the most recent warming in higher latitudes is, however, quite impressive. There are positive trends of sea surface-water temperatures in the North Atlantic of the same order of magnitude as the long-term air temperature changes (*16*). Also, retreats of glaciers (*17*), upward migration of snow lines, lengthening of the freeze-free season, northward migration of animal species and plants (Fig. 7), and phenological data all point in the same direction. There is little doubt that the past two or three decades, taken over-all, have been among the warmest in centuries. The question as to what may be the causes immediately arises. First, let me state that periods of similar warmth have been noted in earlier historical times. Even warmer intervals have occurred since the last glaciation. The most widely held opinion ascribes the changes to variations in the solar radiation. Satisfactory proof for this relationship is still lacking (*18*).

For the latest temperature change, there is an important contender as cause: atmospheric carbon dioxide. There are some interpretations of historical and current observations pointing toward a gradual increase of this atmospheric constituent (*19*). The increased consumption of fossil fuels has brought very large quantities of carbon dioxide into the air. Isotope investigations attest to this fact. Carbon dioxide is an absorber of outgoing long-wave radiation, and hence has an influence similar to that of a glass cover. This phenomenon is therefore often referred to as the "greenhouse effect." Only since the start of the

Fig. 7. The recent warming of the arctic has been particularly notable at the edges of the forested regions both in North America and Eurasia. The tree line has been advancing gradually northward. In some areas which have been resurveyed, the forest has advanced 2 miles northward over the last 30 years. [U.S. Weather Bureau]

International Geophysical Year have there been sufficiently widespread and accurate observations of atmospheric carbon dioxide to enable us to gain perspective on this question. Local variations and the uncertainties in the carbon dioxide balance between ocean and atmosphere make interpretations difficult. For an answer on the role of carbon dioxide in atmospheric temperature trends, many more years of systematic observations will be necessary (*20*).

Even if one accepts the thesis that atmospheric pollutants, such as dust and carbon dioxide, or terrestrially caused changes in atmospheric water vapor content could have an influence on the decadal or perhaps century-long trends, the main question still remains: What causes the large-scale epochal changes? Much thought has been given to this problem in recent years. New techniques, such as oxygen isotope analysis of sea shells, have been applied to it (*21*). But basically no new answers have been obtained.

If anything has happened, the ingenious hypothesis of attributing major climatic changes to the periodic elements in the obliquity of the earth's axis and in the eccentricity of its path (*22*) has lost its attractiveness. These path elements of the planet seem to account for only minor changes (*23*). Some new ideas have cropped up. They link pole shifts, oceanic currents, the ice conditions of the North Polar Sea, and the land glaciations (*24*). There is, of course, a much underrated relation between the oceanic heat (or cold) reservoir and the climatic fluctuations on land. However no *quantitative* consideration has as yet demonstrated that these could account for the observed, and evidently recurring, phenomena of major ice epochs. They may perhaps be adequate to explain stages within these eras.

Sooner or later most considerations get back to the question of changes in the solar radiation. Some astrophysicists contend that there are simply none of the magnitude required for major climatic changes (*25*). Others equally stoutly maintain that nuclear refueling processes on the sun actually call for periodic substantial changes in solar energy output (*26*). A once favored idea that cosmic dust clouds might act as interceptors has not been refuted but no new supporting facts have been marshaled either.

There is no unanimity about what the effects of changes in the solar radiation would be. Some contend that an increase could lead to an ice age (*27*). The essential reasoning is that initially higher temperature and increased circulation would lead to more cloudiness and hence greater albedo values. It is, however, more logical to assume that increases in radiation cause warmer conditions, such as once prevailed in the Tertiary, and that decreases in radiation produce ice ages of the Pleistocene type. Both sides of this question are still being vigorously argued in current writings (*28*).

Climatic "Control"

Of late there has been a great deal of publicity about controlling the climate. The word *control* implies that you know what to do, and when and where to do it. Some of this talk about control can be ascribed to misinterpretation of dimensions. Most of it glosses over the fact that for *major* climatic changes one would have to modify substantially the tremendous amount of solar energy received by the earth. We might note here in passing that the energy liberated from the total probable stores of fission and fusion bombs would not equal the energy of the average thunderstorm activity on earth over a few days' time. Albedo changes can presently be envisaged only on a relatively small scale. Ocean currents are hard to divert; mountains are difficult to move. And these remain the major terrestrial climatic controls.

Conceivably one could throw enough dust into the stratosphere by nuclear explosions to intercept an appreciable amount of the solar radiation. This might, again conceivably, cause some changes of the general circulation. The effect would pass off in a few years—a short time as climatic spans go. Also, the effect would be general over the globe, with unpredictable effects as far as small land segments are concerned. It could hardly be called control.

Some talk glibly about trigger effects. This means that a small amount of energy can set off a much larger, latent energy store. But where is the "loaded gun" in the atmosphere? The nearest analogy is the latent heat of the water vapor. If condensed in spots it could add heat which could be transformed into other forms of energy. Temperatures might be raised, motions increased. Here, too, in spite of the sometimes advocated spreading of hygroscopic nuclei, little in the form of "control" can be foreseen in the near future. There are also some latent electric energies available in the atmosphere. These have hardly been explored yet.

The trigger effects, the albedo effects, even the direct addition and subtraction of energy, can now only be envisaged for local modifications of climate. The microclimate is readily manipulated and much along this line has been accomplished over the last few decades. This includes many of the horticultural practices from frost protection to shelter belts, from moisture-conserving mulching to irrigation. On a somewhat larger scale, creation of artifical lakes, changing of river courses, large-scale reforestation, and artificial suppression of evaporation have small, but measurable climatic influences. Also along this line, slight local increases of orographic rainfall by cloud seeding have been made probable (*29*). Cloud modification, if systematically carried on, by coalescence of droplets or by their dissipation, is among the potential producers of local climatic effects. There is theoretically a bare possibility of operating on the latent energies of severe storms and causing measurable effects. Experimental evidence has yet to be obtained in this respect. If practical, it will have, at best, climatic influences on a meso-scale. In all these aspects, a little more humility in the face of the overwhelming powers of nature seems to be indicated for the present.

Microclimatology and Bioclimatology

It has long been known that in the layers close to the ground, climatic conditions of wide variety can exist in close proximity (*30*). These conditions are often quite different from the general, or macro, climate of the region. Because they are often confined to small spaces they have been labeled microclimates. The term is, however, loosely used in the literature. Some authors restrict it to indicate climatic differences on the smallest scale only. This might show the comparison of the climate of a furrow compared to that of level soil, or the climate on the windward versus the lee side of a small hill or hedge. It might show the climatic difference between a forest and bare soil in the same area. Generally, however, climatic differentiation of somewhat larger scale is usually included in a discussion of microclimatology. In this broader sense the scope of this field includes the contrasts of valley, slope, and crest climates in a hilly terrain, or it pertains to the climates of

a settlement, town, or city as distinct from the surroundings, undisturbed by human activity.

The microclimatic differences are often startling. They develop primarily under conditions of clear sky and little wind, but some still exist with clouds, wind, and rainfall. Human interference, as can be seen from the foregoing, is important in creating and destroying microclimates (*31*). Manipulation of microclimates is, or should be, an important adjunct to planning land utilization, agricultural management, architecture, and urban development. In this connection, it may be interesting to cite a few figures on the major climatic differences between cities and their surroundings (Table 2).

Table 2. Climatic changes produced by cities (*40*).

Element	Comparison with rural environment
Dust and pollution	10 to 25 times more
Radiation	15 to 20 percent less
Clouds	5 to 10 percent more
Precipitation	5 to 10 percent more
Temperature (average)	1 to 2°F more
Relative humidity	3 to 10 percent less
Windspeed	20 to 30 percent less

In many instances air pollution accumulations are direct consequences of microclimatic settings. Topography, source of pollution, and general climatic conditions combine in patterns which become a typical element of local climate. It is feasible to estimate the pollution hazards of an area from climatic records and the terrain features, if sources of contamination come into being.

Microclimatic principles are among the best established in climatology. The facts are usually the most readily amenable to observation. Advanced instrumentation is available (*32*). Quantitative theories that begin to explain the observed facts are in a better state than those of general climatology. Last but not least, experimentation with test plots, not too far removed from laboratory conditions, is feasible and is being carried on.

The microclimatic conditions play an important role in life processes. Some of these influences operate on the smallest scale. Bacterial, fungal, and insect life in plant cover are governed to a considerable extent by prevalent temperature and moisture conditions. Presence or absence of dew on leaves may determine infestations of plant pests. The microclimate in a high stand of grass, for example, may prevent extremes of heat and cold and thus enable survival of certain insects in otherwise lethal conditions. Intricate relations between climate, plant life, and low forms of animal life exist, but much remains to be learned about the microecological complex.

A mixture of both macro- and microclimatological influences operate on plants. These effects have been the target of a great many investigations because of their importance in crop ecology. In its simplest aspects, photosynthesis is, of course, a direct function of sunlight, and hence is subjected to the climatic variations of this element. But this is where simplicity ends in the plant-climate relation. The effect of temperature is fairly well understood, but when it comes to water use, the problems become really involved. In the higher plants, light, heat, and water interact in a nonlinear fashion. At various stages of development the requirements of the plant for optimal conditions change, and the interplay of climatic factors subtly shifts (*33*).

Although a modicum of order for the atmospheric environment can be obtained for plants growing in phytotrons, under field conditions it is hard to ascertain the role of each climatic influence. The only exceptions are singular, lethal events, such as a hard freeze or absolute drought. In their absence one has to ascertain the complex effect of *all* climatic elements on the development of the plant. The use of statistical techniques with multiple regressions is of some help. More commonly, investigators have tried to condense the complex climatic factors into single influence indices. This is helped somewhat by the fact that there exist fairly high correlations between some of the climatic elements. Thus temperature is correlated with sunshine, and water depletion is, to some extent, a function of saturation deficit and wind. These, in turn, vary not entirely independently of temperature and sunshine. Among the influence indices which have been used with some success are the (i) soil temperature at shallow depth; (ii) evaporation (from porous bodies or open water surfaces); (iii) heat sums (expressed in terms of temperature excess above a given threshold); (iv) potential evapotranspiration. The first two are directly measurable; the other two can be derived from simple climatic observations. These influence indices substitute, even if in an incomplete fashion, for radiation, soil moisture depletion, and transpiration from plants. They can be used as correlatives for various stages of phenological developments of plants (*34*).

Similarly complex are the climatic influences on the human and animal bodies (*35*). In the healthy organism we deal with problems of acclimatization. Some phases are well understood. As an example, we can cite the reactions of the human skin to ultraviolet solar radiation. Another one is the adaptation to reduced oxygen tension in the atmosphere, resulting in increased red blood corpuscles and thoracic capacity. Considerable evidence has also been advanced that the primary differentiation of races was caused by climatic conditions (*36*).

The influence of climate on pathological states is not well known. We find ourselves in a vast realm of speculation. Are there climates beneficial to older persons? Opinion leans toward an affirmative answer, specifying as optimal a "mild climate," without extremes of temperature and with a minimum of change. Are climates with low relative humidities beneficial to sufferers from sinus disease? Again, a poorly documented "yes" sums up the present level of knowledge, or better, ignorance.

Seasonal incidence of certain infectious diseases, or geographical distribution of endemic plagues, points toward a climatic causative factor. However, it is not known whether the influence is on the receptiveness of the human organism, on the pathogen, or on the various disease-carrying vectors. Equally ill-established is the role of climate in the air-borne allergies.

Outlook

Let me indulge now in speculating a little where we will go from here in climatological research. It is certain that the vast stores of accumulated climatic observations will be tapped for their concealed information by use of modern electronic methods of data processing. The phases of this work applied to various branches of engineering will flourish. Similarly, much progress can be expected in establishing the true climate of the upper air. From this will be derived dynamic parameters of the general atmospheric circulation which will define local and areal climates. Hand in hand with this will go research on en-

ergy transactions that determine climatic regimes (*37*). As a first step, a comprehensive radiation climatology of the globe is needed.

Better information on extraterrestrial fluctuations of radiation and deeper understanding of the atmosphere-ocean relations will throw new light on the problem of climatic trends. The tedious analysis of geological evidence is likely to leave the problem of ice ages in the state of working hypotheses.

The greatest advances of climatology are destined to lie in the border field of biology, provided an adequate cooperative research program is started. The interactions between the physical changes in the atmosphere and living organisms are too great a challenge to scientific curiosity to remain in a relatively unexplored state. We have already pointed to the special problems of agroclimatology, a solution to which population increase will demand. Similarly, the role of climate in gerontology and various pathological states begs for quantitative studies.

It is further certain that some experimentation with artificial alteration will take place. One can only hope that the long-range view will prevail and that the experiments will be carefully designed with a view toward physical and statistical validation. This is a large program which probably will take years and permit of few short cuts. Man may not become master of his climatic environment, but the next decades at least promise that he will be able to understand it much better than in the past.

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Pavlov and Lamarck

The great Russian scientist once reported experiments in support of Lamarck. Were his final views Lamarckian?

Gregory Razran

Recently Nathaniel Kleitman wrote me: "For quite some time I have been trying to ascertain if Pavlov ever retracted the statement made in 1923, at the International Physiological Congress at Edinburgh, and elsewhere, that successive generations of rats acquired conditioned reflexes with progressively less training. In his review of *I. P. Pavlov: Selected Works*, that appeared in *Contemporary Psychology*, Vol. II, p. 274, Gantt stated that Pavlov 'rescinded this statement about heredity when he had more critically surveyed the original experiments . . .' However, when queried by me on this subject, Gantt said: 'I have no reference to a retraction in print, although there may be one.'"

Analogous questions have been directed at me, from time to time, at meetings and in letters, by a number of American scientists, and once by a member of the State Department. Consideration of the evidence on this matter in its entirety and, for convenience, in chronological sequence, may thus be worth while, particularly since Soviet theorists have for some years been proclaiming Pavlov the true and renowned backer of scientific Lamarckianism or,

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in their own words, "creative Soviet Darwinism, the true and progressive doctrine of creative evolution of life and mind." Let us look at the evidence.

First Mention

Pavlov posited for the first time the possibility of the inheritance of acquired conditioning in 1913, in an address before the Ninth International Congress of Physiologists at Gröningen, and then again in 1914, in an address prepared for an International Congress of Psychiatrists, Neurologists, and Psychologists in Switzerland, which was canceled on account of the war. The exact statement in 1913 was: "It may be assumed that some of the conditioned newly formed reflexes eventually become transformed into unconditioned ones through heredity" (*1*). The 1914 statement, more positive and specific, read: "It is highly probable (and there are to this effect some factual indications) that, when the same conditions of life are maintained in series of successive generations, newly formed [conditioned] reflexes uninterruptedly [in Russian, *neprerivno*] become constant [unconditioned] reflexes" (*2*, vol. 3, p. 222; *3*). No mention whatsoever was made of the problem in any of Pavlov's subsequent writings before 1923.

Edinburgh Inheritance Report

In 1923 came to light what since has often been called "The Edinburgh Inheritance Report." Pavlov came to the United States in the summer of 1923 and delivered one address on 5 July at the University of Chicago and another on 7 July at the Battle Creek Sanitarium. Then he proceeded to Edinburgh (after his wallet containing $2000, was stolen from him at Grand Central Station in New York) to address the 11th International Congress of Physiologists (*4*). The Edinburgh address, identical with the one given at Chicago, was published in the transactions of the congress in the *1923 Supplement Volume of the Quarterly Journal of Experimental Physiology* (pp. 39–43); the Chicago address had appeared earlier in *The Scientific Monthly* [17, 603–608 (1923)]. The Battle Creek address, somewhat shorter than the Chicago–Edinburgh one, was published in the *Bulletin of the Battle Creek Sanitarium* (*5*) and in *Science* (*6*). Both addresses contain the inheritance report, though the version in the Battle Creek address is the longer of the two. It reads (note that in neither is the inheritance section the main theme and that in both it is really only a small, but striking, aside):

"The latest experiments (which are not yet finished) show that the conditioned reflexes, i.e. the highest nervous activity, are inherited. At present some experiments on white mice have been completed. Conditioned reflexes to electric bells are formed, so that the animals are trained to run to their feeding place on the ringing of the bell. The following results have been obtained:

"The first generation of white mice required 300 lessons. Three hundred times was it necessary to combine the feeding of the mice with the ringing of the bell in order to accustom them to run to the feeding place on hearing the bell ring. The second generation required, for the same result, only 100 lessons. The third generation learned to do it after 30 lessons. The fourth generation required only 10 lessons. The last generation which I saw before leaving Petrograd learned the lesson after 5 repetitions. The sixth generation will be tested after my return. I think it very probable that after some time a new generation of mice will run to the feeding place on hearing the bell with no previous lesson.

"It is well known that a chicken when it just comes from the egg immediately begins to pick up any black spot on the floor, trying to find some grain, thus showing that it has an inborn reflex from the eye to food reaction. Why should we not build up the same reaction, not from the eye but from the ear as indicated in the case of the white mice?" (*5*, p. 4; *6*, p. 361).

T. H. Morgan quoted the first two of the aforementioned paragraphs in his *Evolution and Genetics* (1925) with the following comment: "There was some consternation in 1923 when the great Russian physiologist, Pawlow, reported the results of experiments that go far beyond what most Lamarckians have dared hope. Pawlow's conclusions—and as yet we have only his conclusions—are very surprising" (p. 157).

Conditioned Reflexes

In 1927, *Conditioned Reflexes,* consisting of a series of lectures delivered by Pavlov at the Petrograd Military Medical Academy, was published in Russian, and was immediately translated into English by C. V. Anrep, Pavlov writing a special preface to the English edition (*7*). And here on page 385 we find a footnote pertaining to the sentence, "Such criteria [characteristics of types of nervous systems] when perfected should greatly assist the development of a strictly scientific experimental investigation of the hereditary transmission of different aspects of the nervous activities of animals," which reads:

"Experiments which have been communicated briefly at the Edinburgh International Congress of Physiology (1923) upon hereditary facilitation of the development of some conditioned reflexes in mice have been found to be very complicated, uncertain and moreover extremely difficult to control. They are at present being subjected to further investigation under more stringent conditions. At present the question of hereditary transmission of conditioned reflexes and of the hereditary facilitation of their acquirement must be left entirely open" (*7*, p. 385).

Editions of the "Twenty Years"

Neither the Edinburgh–Chicago nor the Battle Creek address was included, during Pavlov's lifetime, in any of the six editions of his *Twenty Years of Objective Study of the Higher Nervous Activity (Behavior) of Animals* (known better in English as *Lectures on Conditioned Reflexes*). The six editions of the *Twenty Years*—so named because the first edition was published in 1923, twenty years after the beginning of conditioning experimentation—are in all respects *complete* collections of Pavlov's formal addresses and articles on conditioning, each edition supplementing the one preceding (dates of editions: 1923, 1924, 1925, 1928, 1932, and 1938), and the last edition containing a preface by Pavlov written about one month before his death. Likewise, there is the striking fact that the topic is nowhere mentioned in any of the five published volumes of *Pavlov's Wednesday Seminars,* supposedly the repositories of everything informal that Pavlov had said about conditioning in the 1930's.

Complete Works

The Battle Creek address first appeared in Russian, with a reference to *Science,* in 1949, in the fifth volume of

the first edition of Pavlov's *Complete Works* (*2*, vol. 5, pp. 309–312) and again in the second part of the third volume of the second edition of the *Works* (1951, pp. 428–432). And it was only then, at the height of Lysenkoism, that Soviet experts on Pavlov—as well as those not so expert—began beating the drum loudly and repeatedly in exultation over the alignment of Pavlov's views and proofs with those of Michurin and Lysenko (the sounds of the drums have weakened considerably in the last two or three years, but, as noted in the aforementioned review by Gantt, they have by no means been wholly silenced). The writings of Y. P. Frolov, a conditioning experimenter and Pavlov popularizer of no mean magnitude, are a particularly appropriate example of this Soviet interplay of *Zeitgeist* and scholarship. In Frolov's 291-page *Pavlov and His Work*, published in 1937 (translated into English), there is not a word about Pavlov and heredity. But in Frolov's 78-page pamphlet *The Great Physiologist, I. P. Pavlov*, published in 1950, a whole section on "Higher nervous activity and creative Darwinism" appears, and Pavlov is quoted to have said:

"For if no one may affect your substance, your gene, Mr. [(*8*)] Morgan, then all that is left for us to do is to merely observe nature, nothing else. What we have then is not a laboratory but a prayer house. But what we wish to do is to actively interpose in [the workings of] nature. And this we will do, Mr. Morgan, your disapproval notwithstanding" (p. 70).

And in the second (1952) edition of the pamphlet there is an additional final phrase ". . . and we will produce the facts to prove our claims."

Oral Comments

The quotation from Gantt given in Kleitman's letter contains also the sentence: "Pavlov remarked to me that one of the biggest scientific errors of his life was his assertion that acquired habits could not be inherited." And to this I would like to add that, while spending a summer afternoon with Pavlov in 1934, I asked him specifically what his present views on the problem were. His answer was a shoulder shrug coupled with the sound of a typical Russian "Ekh" which to me meant "Don't ask," and I preferred not to pursue the question.

Conclusion

Though there is no evidence that I. P. Pavlov ever formally renounced Lamarcks' *doctrine as such* (only a personal statement to Gantt and my own "Ekh" impression), Pavlov certainly retracted specifically the positive results of his experiment—and the fact that he never repeated the experiment, as intended, and shunned any discussion of the topic, may well be construed as evidence that he did not expect positive results to be obtained. Soviet theorists' wholesale alignment of Pavlov with Lamarck, Michurin, and Lysenko is thus a gross misrepresentation of a great and careful experimenter and of a critical and discriminating discoverer and blazer of new truth and evidence. Let us hope that this practice of subserving exact science to social dogma is on the wane. There is some reason to believe that it is.

References and Notes

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2. ———, *Complete Works* (Akad. Nauk S.S.S.R., Moscow, ed. 1, 1949), vol. 3, p. 222.
3. ———, *Lectures on Conditioned Reflexes* (International Publishers, New York, 1928), p. 242.
4. The statement in *Science* [**58**, 45 (1923)], reprinted from the *New York Times*, that "Pavlov was refused a British visé to his passport . . . and will not be able to attend the Edinburgh Congress of Physiology," should be emended. The British Consulate in New York did refuse Pavlov a visa. However, the Central Government in London yielded to protests from American and British scientists and finally granted him the visa while he was on the high seas. The Pavlov address was read in English by his son, Vladimir Pavlov, while, according to A. N. Richards and J. T. Wearn (*New Yorker*, January 20, 1951), "Professor Pavlov stood before a huge audience in Edinburgh . . . following every word, now and then nodding his head vigorously and muttering, *'Da, da.'*"
5. I. P. Pavlov, *Bull. Battle Creek Sanitarium* **19**, 1 (1923).
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News of Science

Traveling Science Library

This year the American Association for the Advancement of Science and the National Science Foundation, cooperatively with book publishers of the United States, will provide about 1400 of the nation's senior high schools with 350 "circulating libraries," each consisting of 200 carefully selected science books. The AAAS Traveling High School Science Library Program is being supported for the fourth year by an NSF grant. The current award, announced today, amounts to $500,000.

During its first year of operation the Traveling Science Library circulated 11 sets of 150 books among 66 senior high schools. Last year demand was so great that the AAAS could honor only a fraction of the applications it received. The new NSF grant makes possible the current expansion of the program. The library will go to schools in all 48 states, Alaska, the Canal Zone, Hawaii, and Puerto Rico. Fifty books will be sent at a time, with an exchange approximately every 2 months, so that each school will have use of a complete set during the year.

Evaluation studies made by the AAAS disclose that on the average only 5 percent of books in most high-school libraries concern science and mathematics. The studies also indicate that the traveling libraries provide an effective incentive for participating schools to take action to satisfy, in varying degree, the appetite for science reading stimulated by the AAAS books. Publishers, almost without exception, have provided the books at cost.

Objectives of the Traveling High School Science Library Program are as follows:

1) To develop in high school students

an interest in reading general books about science and mathematics, other than textbooks.

2) To provide, on an experimental basis, a collection of carefully chosen books as a basis for developing the reading interests.

3) Stimulate an interest in choosing a career in science.

4) Offer science teachers an opportunity to broaden their subject-matter knowledge and encourage them to stimulate collateral reading on the part of their students.

In addition to the 350 sets of books that are a part of the regular program, this year an additional seven sets are being lent to the Department of the Army for circulation among the 20 senior high schools that are operated in France, Germany, Italy, and Okinawa for the children of United States citizens serving overseas. Furthermore, four sets will be lent to county library systems for circulation in bookmobiles as an experiment on the appeal of science books to adults and students in rural areas where high schools are too small to participate in the program.

To facilitate use of the books, the AAAS has each year published an annotated catalog, *Books of the Traveling High School Science Library,* popular not only with high-school librarians and teachers but also with community and university librarians and the general public. Demand has increased each year, from 3000 copies in 1955–56 to 22,000 copies in 1957–58.

The AAAS hopes to publish before year-end *A Comprehensive List of Science and Mathematics Books for Secondary School and Community Libraries.* Book publishers of the nation have sent to the AAAS free of charge copies of all books on the preliminary list of 1000 books. These are being evaluated by representatives of AAAS-member scientific and professional organizations.

To encourage young people to read science and mathematics books and to call their attention to the many good books available in paperbound editions, the AAAS published as an experiment in September 1957 a list of these paperbacks entitled *"An Inexpensive Science Library,* with a first printing of 12,000 copies. The list proved so popular that the first printing was exhausted by December 1957 and an additional 10,000 were printed; these were all distributed by April 1958. A new and enlarged edition has been published.

FAS Urges Halt to Test Series

The Federation of American Scientists Executive Committee has addressed an open letter to the President urging him to halt the new series of ten nuclear tests scheduled to take place in Nevada, just before the test-ban negotiations begin with the U.S.S.R. on 31 October. The letter reads in part:

"We were . . . encouraged by the recent agreement between nuclear experts of the East and West on the technical feasibility of policing a nuclear test ban, followed by your Aug. 22nd proposal to halt nuclear testing for a one year period, providing the Russians continue to abstain from testing for the same period and agree to start discussions October 31.

"Barely a week later, on Aug. 29, the climate of encouragement engendered by your statement was unfortunately dispelled by the startling Pentagon-A.E.C. announcement that the US would carry out a new series of ten tests in Nevada just before the Oct. 31 deadline on the very eve of the vital negotiations. In the eyes of the world, this announcement casts considerable doubt on our sincerity in desiring a workable test ban agreement.

"The Federation of American Scientists urges you, Mr. President, to stop the proposed Nevada test series. Such action on your part would emphasize our earnest desire that an agreement be reached to halt nuclear weapons testing as a first step towards disarmament and world peace. Even if extensive preparations have been made and important information will be gained from these tests, the adverse propaganda effect must be seriously considered. A declaration on your part that these tests will not be held would reestablish our high purposes in the eyes of the world and insure all concerned of our true desire to take steps aimed at achieving a stable peace."

National Science Youth Month

October has been designated National Science Youth Month by the President's Committee on Scientists and Engineers. During the month, many national organizations, including the AAAS, are taking an active part in stimulating the interest of high school students throughout the country in scientific studies. A science youth organizations working group appointed by the President's Committee is leading the activities for the Month, with Science Service, Washington, (D.C.) as the coordinating agency.

During October, science teachers are being asked to start science projects to be carried out during the school term. Other suggested activities include: PTA, professional and civic meetings in October devoted to science subjects; science fairs; affiliation of local science clubs with Science Clubs of America; registration by school principals for qualifying tests for National Merit scholarships and for Science Talent Search examinations; student assemblies featuring scientific or technological speakers; personal contacts between scientists, engineers, and students through "project nights" devoted to work on science-fair projects, or through "career sessions" when engineers and scientists discuss career opportunities and interesting experiences in their fields.

A poster-calendar for science classrooms and school bulletin boards provides a check-list of important dates and actions to be carried out during Science Youth Month. The poster has been distributed to the nation's 25,000 science teachers. (Additional single copies can be obtained from the President's Committee on Scientists and Engineers, Washington 25, D.C.)

Reading Machine for the Blind

Development of a new device with which the blind can read ordinary printed material, such as books and magazines, was reported recently by the Veterans Administration. The portable unit, called an "aural reading machine," was designed and is being evaluated by the Battelle Memorial Institute of Columbus, Ohio, under a VA contract.

At the present stage of development of the reader, the sounds it produces do not resemble those of speech but are patterns of musical tones similar to chords played on an organ. By interpreting these tones, trained users ultimately should attain a reading speed of from 15 to 30 words per minute. Advantage of the machine over Braille is that the blind user can read material in normal print, including typewritten business correspondence.

The reader is about the size and shape of a portable radio. Weighing about 9 pounds and housed in a wooden case measuring about 7 by 9 by 8 inches, it has knobs for volume, light intensity, and the electric power switch.

The machine has three essential parts —a small probe which is held in the hand and moved over the printed material to be read, a chassis containing transistorized oscillators and an amplifier, and earphones through which the user listens.

The probe contains two tiny lights and a lens that projects an image of the printed letter upon a row of photocells. Each photocell, when it "sees" black, turns on an oscillator in the chassis that generates a specific pitch proportional to the height of the black portion of the letter "seen." These pitches are translated to sound patterns by the earphones.

Blind persons, chiefly students and faculty members from the Ohio State School for the Blind at Columbus, have been trained to interpret sounds of the Battelle machine during the past year.

Each student in the participating group received about 18 hours of instruction on the device, following preliminary training in interpreting tape-recorded sounds of the machine.

Recognition of the tape-recorded sound patterns corresponding to 145 different sentences was learned fairly readily, but the complex operation of manually rolling the probe along the line of print while interpreting the tone patterns will require considerable further practice before routine use. Only five prototype models of the reader have been made, and further development of both the device and training methods will be required before quantity production is advisable.

Middle East Population

The Population Reference Bureau, Washington, D.C., reports that the population of the Middle East is growing by 4 million people a year (equivalent to the population of Chicago). Any plan to raise the standard of living in the Middle East, such as that suggested by President Eisenhower, will have little effect unless the population growth can be brought under control. The President recently laid before the United Nations a proposal for a regional Arab development institute that would provide for improved health, education, irrigation, and so forth. The Population Reference Bureau points out that the area's 95.7 million people have increased by 15 percent in 5 years. The rate of growth, in an area already heavily crowded in terms of habitable land, is exceeded only by that of Tropical South America.

The bureau lists these problems in the Middle Eastern population situation: large stretches of barren land; a falling death rate and a high birth rate; a predominantly illiterate agricultural population with little knowledge of modern techniques; and a Moslem tradition of taking great pride in large families. It is emphasized that there appears to be no religious mandate regarding fertility control in the Moslem world. This attitude can change when it is understood that high fertility blocks the hope for a better life.

Antarctic Research

The Arctic Institute of North America will participate in the U.S. Antarctic Research Program under the sponsorship of the National Science Foundation and the National Academy of Sciences. Seven new programs have been planned in order to continue international scientific collaboration in the Antarctic after the close of the International Geophysical Year in December.

The programs to be undertaken by the Arctic Institute include 2-year studies in glaciology and in seismology that will involve eight scientists in investigations of the ice-cap and its base rock in hitherto untraversed areas of the continent. A program of auroral observations at the Byrd and Pole stations will also be conducted through 1959 and 1960, in cooperation with scientists from New Zealand and Australia at the Hallett, Wilkes, and Ellsworth stations.

A further responsibility of the Arctic Institute is the coordination of a program in the biological and medical sciences. This will include the establishment of a biological laboratory at the Naval Air facility at McMurdo Sound for the use of zoologists, microbiologists, and physiologists. Other programs deal with ice studies and microflora collections. Scientists for all the newly announced programs are now being selected.

Grants, Fellowships and Awards

General. The British Government is calling for applications for its 1959 Marshall Scholarship Awards. Students are being urged to get their applications in *before 31 October,* when the lists close. Requirements for these 2-year study grants, 12 of which are awarded each year, are liberal. Any American student (including inhabitants of Hawaii and Puerto Rico) of either sex, married or single, may apply—provided he or she has earned a first degree at a recognized university and is under the age of 26 on 1 October 1959.

Each award is worth around $1400 a year, for 2 years (and occasionally 3), plus tuition at a United Kingdom university, if possible of the applicant's choice. This is estimated to be sufficient for student life in Britain. Passage to and from the United Kingdom is paid. Married men get an extra allowance.

Applications should be made to the British consul-general in one of the following cities: Chicago, New York, New Orleans, or San Francisco. The Marshall Scholarship Scheme was begun in 1953. It is intended to express Britain's gratitude for Marshall Aid.

Pediatrics. Grants providing for postgraduate pediatric studies will be awarded again in 1959 by Wyeth Laboratories, Philadelphia. The firm will award 20 2-year grants, each carrying an annual stipend of $2400. The first 3 years of the program will cost $195,000.

Candidates for the pediatric fellowships may include interns, physicians who have recently completed their internship, military service, or a U.S. Public Health Service tour, and research fellows. All recipients must be citizens of the United States and Canada.

Applications must be submitted *by 28 November.* Information and application forms may be obtained from Dr. Philip S. Barbar, University of Pennsylvania School of Medicine, Philadelphia, Pa.

NSF Summer Conferences for College Teachers

The National Science Foundation has announced that it will support in 1959 an experimental program of some 20 Summer Conferences primarily for college teachers of science and mathematics. The Summer Conferences will be of shorter duration but generally similar to the Summer Institutes that the foundation has supported in recent years. Colleges and universities interested in sponsoring such conferences are invited to request further information from the Program Director for Summer Institutes, National Science Foundation, Washington 25, D.C. The deadline date for submission of proposals is *15 December 1958.*

Although planned and sponsored by the nation's institutions of higher learning, Summer Conferences will be supported by foundation funds to defray direct operational costs plus expenses of participants. Summer Institutes, 125 of which were supported by the foundation in 1958, are usually from 6 to 10 weeks in length and have been predominantly for high school teachers. In contrast, Summer Conferences will extend over a 1-to-3-week period and will be primarily for college teachers. In a few cases secondary-school teachers may be included for particular purposes. As with Institutes, Summer Conferences will emphasize subject matter rather than methods of teaching.

Radioactivity in Milk

The Public Health Service has announced that its latest tests for the presence of radioactivity in milk from nine locations in the United States have shown amounts well within the permissible levels recommended by the National Committee on Radiation Protection and Measurement. The new report, which covers the months of May, June, and July, brings up to date the findings of the study initiated by the Public Health Service in the spring of 1957. A report on the first-year findings was issued on 25 May 1958.

During June and July, the network of sampling stations was expanded from five to nine. The four new stations reporting for the first time are on the milksheds of Atlanta, Ga.; Austin, Tex.; Fargo, N.D.; and Chicago, Ill. An additional sampling point is being established in Spokane, Wash. New labora-

tory techniques have been introduced and instruments have been recalibrated to simplify sampling procedures and make them more accurate. Data previously reported have been adjusted to conform to new values resulting from these changes.

Levels of strontium-90 in the May samples were found to range, in the various milksheds, from 3.3 to 10.0 micromicrocuries per liter, as compared to the permissible limit of 80.0 μμc/liter. The yearly average for the period ending May 1958 for strontium-90 ranged from 4.1 to 9.4 μμc/liter.

Levels of strontium-90 in the June samples were found to range from 2.2 to 15.5 μμc/liter. The yearly average for the period ending June 1958 ranged from 4.2 to 9.6 μμc/liter.

In the July samples, the levels of strontium-90 were found to range from 3.3 to 18.7 μμc/liter. The yearly average for the period ending July 1958 ranged from 4.2 to 10.2 μμc/liter.

The maximum permissible levels recommended by the National Committee on Radiation Protection and Measurement represent concentrations which are currently considered safe over a lifetime and which may occasionally be exceeded for short periods of time.

Other radioactive elements found were also well below the permissible limits. For the period ending May 1958, the 12-month average levels for these elements, in micromicrocuries per liter, were as follows: iodine-131, 27 to 234 (permissible limit, 3000); strontium-89, 23 to 76 (permissible limit, 7000). Barium-140, 19 to 88 (permissible limit, 200,000); cesium-137, 43 to 60 (permissible limit, 150,000).

Science Legislation and the 85th Congress

In various issues of *Science* published during the period from last January to the present, there have appeared a number of items bearing the title Proposed Legislation. These items listed the bills introduced in Congress that seemed to have particular relevance to science, education, conservation, and other fields which might be of interest to readers of this magazine. During the course of the second session of the 85th Congress some of these bills were dropped, others were modified or incorporated into other legislation, and others were passed in the form in which they were introduced. Here, a review of a majority of these proposed bills is presented with notes on their history as they went through the legislative process and their status now, whether it be dead, pending, or public law.

Two points should be kept in mind for a valid reading of the information presented. First, it should be realized that many bills receive no action because their provisions are transferred to another and different bill, and second, that many bills are imitative or are introduced more with the record in mind than with any hope or desire on the part of the sponsor that the bill actually be enacted.

Below, the précis of the bills are grouped according to the general field with which they are concerned. A brief statement of status follows the listing of each bill. (S, Introduced in the Senate; HR, introduced in the House of Representatives.)

Education

S 2916. Provide for grants to states to assist them to increase salaries of teachers of science in secondary schools and provide necessary equipment to use in connection with instruction of scientific subjects in such schools. Thye (R-Minn.). Senate Labor and Public Welfare.

No action.

S 2917. Promote general welfare of U.S. by providing program of scholarships for college undergraduate and graduate level education to be administered by Commissioner of Education. Thye (R-Minn.). Senate Labor and Public Welfare.

No action.

S 2956. Amend Vocational Education Act of 1946 to promote scientific education. Monroney (D-Okla.), Kerr (D-Okla.), McNamara (D-Mich.). Senate Labor and Public Welfare.

No action.

S 3187. Strengthen national defense, advance cause of peace, and assure the intellectual pre-eminence of the U.S., especially in science and technology, through programs designed to stimulate their development. Hill (D-Ala.) and 26 other senators.

No action. Similar to HR 13247 National Defense Education Act (Public Law 864) [Science **127**, 389 (21 Feb. 1958); **128**, 289 (8 Aug. 1958); **128**, 521 (5 Sept. 1958)]

HR 9634. Expedite utilization of television facilities in our public schools and colleges, and in adult training programs. Boggs (D-La.). House Education and Labor.

No action, but a similar provision went into Public Law 864.

HR 9620. Amend P.L. 874, 81st Congress, re assistance for maintenance and operation of schools in federally impacted areas, extend its effectiveness for two additional years. Auchincloss (R-N.J.). House Education and Labor.

No action, but a similar bill (HR 11378) was passed and signed by the President (Public Law 620).

HR 9635. Provide for establishment of national program of science scholarships; provide for establishment of a program of loans to educational institutions to aid in providing adequate science facilities. Brooks (D-Tex.). House Education and Labor.

No action, but some provisions contained in Public Law 864.

HR 9905. Authorize Secretary of Defense to grant scholarships and fellowships in scientific fields to promote defense and security of U.S. Dingell (D-Mich.). House Armed Services.

No action.

HR 9830. Authorize appropriation of funds to assist States and Territories in financing a minimum foundation education program of public elementary and secondary schools, and in reducing inequalities of educational opportunities through public elementary and secondary schools, for general welfare. Perkins (D-Ky.). House Education and Labor.

No action.

S 3179. Authorize federal assistance to states and local communities in financing an expanded program of school construction to eliminate national shortage of classrooms. Kennedy (D-Mass.). Senate Labor and Public Welfare.

No action.

S 2938. Amend Internal Revenue Code of 1954 to allow additional income exemption for an individual who is a student at an educational institution above secondary level. Frear (D-Del.). Senate Finance.

No action.

S 3156. Provide for expansion of certain programs for advance education for teachers in science and for establishment of certain programs for advance education for teachers in the humanities. Flanders (R-Vt.), Bricker (R-Ohio). Senate Labor and Public Welfare.

No action. Some provisions in Public Law 864.

S 3311. Authorize assistance to states and local communities in remedying the inadequacies in number of their teachers and teachers' salaries and shortage in classrooms. Murray (D-Mont.), Mansfield (D-Mont.), Cooper (R-Ky), Morse (D-Ore.), McNamara (D-Mich.), Langer (R-N.D.). Senate Labor and Public Welfare.

No action.

HR 9692. Provide for a scholarship program to aid in maintaining and strengthening U.S. leadership in certain fields of science and technology. Martin (R-Mass.). House Education and Labor.

No action. Scholarship provision was dropped in National Defense Education Act. (Public Law 864.)

HR 10454. Establish a scholarship program to train scientists and technicians; provide scholarship beneficiaries be obligated to serve in Armed Forces

upon completion of their education. O'Konski (R-Wis.). House Education and Labor.

No action.

HR 10842. Encourage expansion of teaching and research in education of exceptional children through grants to institutions of higher learning for training of personnel with advanced professional skills in special education. McGovern (D-S.D.). House Education and Labor.

No action.

HR 11833. Encourage expansion of teaching and research in education of mentally retarded children through grants to institutions of higher learning and to state educational agencies. May (R-Conn.). House Education and Labor.

No action.

HR 11329. Amend title IV of Housing Act of 1950 to authorize loans under college housing loan program for construction of science buildings and libraries at educational institutions. O'Brien (D-N.Y.). House Banking and Currency.

No action.

S 3642. Provide for accelerated development of secondary school education in natural sciences in the several states and territories. Yarborough (D-Texas). Senate Labor and Public Welfare.

No action.

S 3606. Provide financial assistance to the states for educational purposes by returning to the states a portion of federal income taxes collected therein. Proxmire (D-Wis.). Senate Labor and Public Welfare.

No action.

HR 12127. Provide for a program of federal grants-in-aid to assist the states to establish and maintain science and technological centers providing adequate facilities for advanced education and research in certain fields of science and engineering. Matthews (D-Fla.) House Education and Labor.

No action.

HR 11830. Provide for a federal program of loans to encourage and assist able and needy students to continue their education beyond the high-school level. Lane (D-Mass.). House Education and Labor.

No action. Similar provisions in Public Law 864.

HR 10180. Amend National Science Foundation Act of 1950 to encourage training of additional engineers and scientists and expansion of facilities for engineering and science education by providing scholarships and fellowships for engineering and science students. Sikes (D-Fla). House Interstate and Foreign Commerce.

No action.

HR 10290. Amend Outer Continental Shelf Lands Act in order to provide that revenues under provisions of such act be used as grants-in-aid of primary, secondary, and higher education. Udall (D-Ariz.). House Judiciary.

No action.

(The status of other proposed legislation described in *Science* over the past 9 months will be given in News of Science in the next issue. The bills reported on will be those relating to general scientific activities, federal agencies, conservation, commerce, and others.)

Scientists in the News

NORMAN TOPPING, nationally known for his research and administrative work in education and medicine, took office on 2 September as the seventh president of the University of Southern California, his alma mater. He will be installed in traditional inauguration ceremonies on the campus 23 October. Topping returned to Southern California from the University of Pennsylvania, where he had been vice president for medical affairs for 6 years. He formerly was an assistant surgeon general of the U.S. Public Health Service and associate director of the National Institutes of Health.

Three members of the National Academy of Sciences–National Research Council Committee on Undersea Warfare were honored recently for their contributions to the Department of the Navy in the field of scientific research and development. At an informal dinner in Washington, Admiral ARLEIGH A. BURKE, Chief of Naval Operations, presented Navy Distinguished Public Service Awards to ERIC A. WALKER, president of Pennsylvania State University, and GAYLORD P. HARNWELL, president of the University of Pennsylvania. JOHN S. COLEMAN, executive secretary of the Academy-Research Council's Division of Physical Sciences, received the Navy Meritorious Public Service Award.

ANTHONY C. CLEMENT, professor of biology at Emory University, has been named program director for developmental biology, Division of Biological and Medical Sciences, National Science Foundation. Clement is on leave from Emory.

DONALD B. McMULLEN, chief of the department of medical zoology at the Walter Reed Army Institute of Research, will serve the World Health Organization for 15 months. He is to be the epidemiologist on a two-man team that will undertake a study of methods for preventing the spread of schistosomiasis in hydroelectric, irrigation, and drainage projects in the Middle East and Africa. Headquarters will be WHO's Section of Endemo-epidemic Diseases, Geneva, Switzerland, but most of the time will be spent in the field. It is expected that initial surveys will be made in eight countries by the end of 1958.

AKIRA NOMOTO, professor at Chuo University in Japan, is serving this year as visiting professor in the department of mechanical engineering at Case Institute of Technology.

In the same department, NIMET OZDAS, formerly on the faculty at Massachusetts Institute of Technology, will serve as visiting associate professor. Ozdas received his diploma in engineering in 1946 from the technical University of Istanbul, Turkey, and his Ph.D. in 1951 from the Imperial College in London, England.

Two electrical engineers will receive Howard N. Potts Medals from the Franklin Institute on 15 October. EMANUEL ROSENBERG of Bogotá, Colombia, is being honored "for his conception of a fundamentally new principle for deriving electrical current from a rotating machine and for his solution of the many technical problems related to the development of the Cross-Field Generator." WILLIAM NELSON GOODWIN, JR., of New Hope, Pa., is being honored for "his many contributions to the field of electrical measuring instruments of which the thermal ammeter, the vacuum tube tester, and the rectifier instrument are examples, and in particular for his work on photoelectric exposure meters and establishing a scale for film speeds."

Dr. and Mrs. JAMES F. TAIT of London have joined the research staff of the Worcester Foundation for Experimental Biology, where they began work on 1 October following a lecture tour. Tait, in collaboration with his wife, (Sylvia A. Simpson) is codiscoverer of aldosterone, a natural hormone of the adrenal cortex which regulates the sodium-potassium balance of the body.

This year's honorary degree recipients include the following:

W. G. CADY, professor emeritus of physics at Wesleyan University, from Wesleyan University.

EARLE C. SMITH, chief metallurgist and director of research at Republic Steel Corporation, Cleveland, Ohio, from Ohio State University.

GILBERT L. STOUT, chief of the bureau of plant pathology in the California Department of Agriculture, from Miami University.

HOMER S. SWINGLE, professor of fisheries management at Alabama Poly-

technic Institute, from Ohio State University.

CARL J. WIGGERS, professor emeritus of physiology at Western Reserve University, from Ohio State University.

GLEN D. CAMP, professor of operations research at George Washington University, has been appointed professor of engineering administration at Case Institute of Technlogy.

Another institute appointment is that of LUCIEN SCHMIT as associate professor of civil engineering. He was formerly at Massachusetts Institute of Technology.

The Institute of Radio Engineers has announced its 1959 awards, which will be presented at the IRE national convention banquet next March in New York City.

E. LEON CHAFFEE, former director of the Cruft Laboratory, Harvard University, is to receive the IRE Medal of Honor, the highest technical award in the radio-electronics field, "for his outstanding research contributions and his dedication to training for leadership in radio engineering." Chaffee, whose career at Harvard began in 1911, is Rumford professor of physics, emeritus, and Gordon McKay professor of applied physics, emeritus.

The Morris Liebmann Memorial Prize will go jointly to CHARLES E. TOWNES, professor of physics, Columbia University, and NICOLAAS BLOEMBERGEN, Gordon McKay professor of applied physics, Harvard University, "for fundamental and original contributions to the maser."

JACK W. HERBSTREIT, chief of the tropospheric propagation research section, National Bureau of Standards, has been named to receive the Harry Diamond Memorial Award "for original research and leadership in radio-wave propagation."

The Vladimir K. Zworykin Television Prize will go to PAUL WEIMER, group leader of pickup tube research, RCA Laboratories, "for contributions to photoconductive-type pickup tubes."

THOMAS F. ANDERSON, formerly of the Johnson Research Foundation of the University of Pennsylvania School of Medicine, has joined the staff of the Institute for Cancer Research, Philadelphia, Pa., as a senior member of that group. Anderson will retain the title of professor in the department of biology at the University of Pennsylvania.

GREGORY PINCUS, director of research at the Worcester Foundation for Experimental Biology, is chairman of the Subcommittee on Program for the first International Congress of Endocrinology, which will be held in Copenhagen in 1960. The subcommittee is organizing the program for the congress, arranging a series of symposia and sessions for briefer papers. Other members of the group include ROLF LUFT of Stockholm; ROBERT COURRIER of Paris; JOHN LORAINE of Edinburgh; HECTOR CROXATTO of Santiago; A. QUERIDO of Leiden; and FRANK ENGEL of Durham, N.C. The committee's first meeting was held in Paris on 29 August.

E. O. FIELD, division of radiobiology, radiotherapy department, Royal Marsden Hospital, London, has been appointed visiting instructor in medicine at Stanford University School of Medicine, San Francisco, for the academic year 1958–59. Field will collaborate on hematology research being conducted in the isotope laboratory by the departments of medicine and radiology.

FRED J. EMMERICH, former president and chairman of the board of the Allied Chemical Corporation and now one of its directors, has received the Chemical Industry Medal of the Society of Chemical Industry.

ROY E. MORSE, professor of food science, has been named chairman of the department of food science of the N.J. Agricultural Experiment Station, Rutgers University. He succeeds WALTER A. MACLINN, who resigned recently to become executive director of the Refrigeration Research Foundation, Colorado Springs, Colo.

B. ROSS GUEST, chief civilian, Air Intelligence Estimates Branch, Office of the Assistant Chief of Staff, Intelligence, Department of the Air Force, Washington, D.C., has been appointed an associate professor in the earth science department, Northern Illinois University.

EDGAR H. DIX, JR., assistant director of research for the Aluminum Company of America since 1942, has retired. Dix has been directly or indirectly responsible for the development of many of the aluminum alloys used today, which now number 70.

GEORGE M. BRIGGS, chief of the nutrition unit, Laboratory of Nutrition and Endocrinology, National Institute of Arthritis and Metabolic Diseases, was recently awarded the 1958 Borden Award for his outstanding contributions during the past years to the advancement of basic research in poultry science. The award, consisting of a gold medal and $1000, was sponsored by the Poultry Science Association. Briggs was particularly cited for his work with vitamin B_{12} and its relationship to other diet components, such as fat and amino acids. The use of synthetic diets that Briggs developed has been especially effective in determining the effect of a single basic food element on growth and physical development.

MARTIN E. HANKE, associate professor of biochemistry at the University of Chicago, has been named director of the Clinical Chemistry Laboratory in the Division of Biological Sciences of the university's School of Medicine. Hanke's research interests have included isotopic studies on the reaction mechanism in the enzymatic decarboxylation of amino acids, serum proteins in cancer, oxidation-reduction potentials in bacterial cultures, and preparation of organic arsenic and mercury compounds.

ROBERT E. HENZE, associate professor of biochemistry at Purdue University, has been appointed to the headquarters staff of the American Chemical Society in Washington, D.C., to coordinate the society's education program.

JOHN N. HOBSTETTER, member of the technical staff of the Bell Telephone Laboratories, has been appointed associate professor of metallurgical engineering at the University of Pennsylvania.

Recent Deaths

JACK K. FINNEGAN, Richmond, Va.; 42; associate professor of pharmacology at the Medical College of Virginia; 13 Sept.

MATT C. JACOBS, Rochester, N.Y.; 62; professor of medical illustration at the University of Rochester; former president of the National Association of Medical Illustrators; 13 Sept.

LEWIS KNUDSON, Ithaca, N.Y.; 74; professor emeritus of plant physiology of New York State College of Agriculture, Cornell University; had been on the university's staff for more than 40 years; 31 Aug.

FREDERICK B. LAFORGE, Washington, D.C.; 76; chemist with the U.S. Department of Agriculture since 1915; specialist on insecticides; author of more than 100 papers and holder of a number of patents; 4 Sept.

JAY L. WIERDA, Philadelphia, Pa.; 60; associate professor of dental anatomy and a member of the faculty of the University of Pennsylvania Medical and Dental Schools for 28 years; formerly taught at Johns Hopkins University, Guilford College, Duke University, Cornell University, and Ohio State University; 5 September.

Book Reviews

Listening in the Dark. The acoustic orientation of bats and men. Donald R. Griffin. Yale University Press, New Haven, 1958. xviii + 413 pp. Illus. + plates. $7.50.

Under this title D. R. Griffin of Harvard has produced an outstandingly thorough and able survey of the problem of echolocation in animals. The problem of how a bat flying in the dark can avoid collision, not merely with cliffs, trees, and walls but even, in darkened rooms, with quite fine wires, has intrigued naturalists since the time of Spallanzani (1729–99).

One of the most attractive features of the present work is the thorough and appreciative account it contains of Spallanzani's experiments—an account which shows him to have been not only an incisive thinker but a master of the experimental method long before his time. The suggestion that the bats might, in fact, be navigating by some form of echolocation was indeed foreseen by Spallanzani, who suggested that the sounds of bats' wingbeats might perhaps be heard after reflection from obstacles.

It was not until 1912 that Sir Hiram Maxim, unaware of Spallanzani's suggestion, put forth the idea that bats could successfully avoid obstacles by means of sounds of about 15 cycles per second—that is, below the human auditory range, this frequency being roughly that of the wingbeat of some of the smaller bats. As we now know, it is the opposite end of the spectrum which is involved, and in 1920 the English physiologist Hartridge, as a result of the developments of underwater sound signalling after World War I, suggested that bats might use sounds of high frequency and short wavelength in their avoidance of obstacles. This was a suggestion only, without any experimental support. Indeed it was not certain whether Hartridge had in mind high auditory frequencies, 15 to 20 kilocycles, or frequencies above the range of the human ear; but, as Griffin points out, he was certainly the first to appreciate and emphasize the great advantage that a bat might be expected to gain by using high frequencies and short wavelengths. The development of radar in World War II was, incidentally, an important factor in bringing the author of this work to the subject, and 1944 saw the publication of the first of an important series of papers by him and his associates.

Hartridge returned to the subject in 1945 and 1946. It has since been the chosen field of several able sensory physiologists, but among these Griffin himself has been outstanding, and—partly because he is also a first-rate naturalist—it is primarily to him that we owe the development of one of the most surprising and absorbing recent chapters in zoology. Many problems remain for further investigation and innumerable byways offer themselves for exploration, but the main lines of the story now seem to be established beyond doubt. The conclusion is that all groups of bats except the Megachiroptera, which are primarily visual animals, control their flight by emitting brief pulses of sound, either well above the human auditory range or at least containing strong supersonic components. These pulses are often highly directional, so that with them the bat can scan its surroundings as one might do with the beam of an electric torch, and where—as in many species—the pulses are of very high intensity, they enable the bat to perceive, follow, and catch flying insects solely by the echoes which return to it from the insect's body. It is extraordinarily difficult for us human beings, visual animals that we are, to imagine ourselves into this world of sound, but Griffin's descriptions are so vivid and lively that he succeeds in familiarizing us with the acoustic world of the bats where many others would fail.

Much of the book is highly technical. Many of the chapters contain material not previously published and perhaps more appropriate for scientific journals than for a book intended for the general zoologist; but the whole is so well done and the story is such an exciting one that even the reader quite ignorant of acoustics and radar is likely to emerge not merely much better educated but an enthusiastic student of the natural history and physiology of bats. The story of Griffin's work on the bats must certainly take its place as one of the major developments in natural history of the present period.

But of course it is not only bats that achieve echolocation; there are also absorbing chapters on the echolocation methods of fish, marine mammals, and, above all, birds. Griffin himself has established beyond doubt that the "oilbird" or "guacharo" (*Steatornis caripensis*), the extraordinary vegetarian nightjar of South America, finds its way in its home caves by just the same method, save that the sounds used probably do not contain important supersonic components. There is now strong circumstantial evidence that swifts of the genus *Collocalia* also have the same ability.

Finally, not the least of the merits of Griffin's book is that it makes clear the problems yet to be tackled. How is it that many bats can undertake long-distance homing and migration flights at night under circumstances in which echolocation can be of little, if any, use? How do the fish-eating bats perceive echoes from fish beneath the surface of smooth water, a surface which must be almost completely reflecting even to the intense high-frequency sounds of bats? How indeed do bats avoid collision with smooth water surfaces when drinking? In some way they must overcome the difficulties caused by specular reflection. These and many other points remain to be worked out, and we have little doubt that Griffin will continue to be a pioneer in their study.

This distinguished book ends with a number of chapters on general problems and prospects raised by these studies, not least of which is the likelihood that some of the methods bats employ might be effectively harnessed for the service of the human blind. Blind persons, as is now well known, may become remarkably proficient at avoiding collision by means of the perception, often unconscious, of echoes of footsteps and of such sounds as the tapping of a stick, as these come back to them.

W. H. THORPE
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Volumetric Analysis. vol. III. *Titration Methods: Oxidation-Reduction Reactions.* I. M. Kolthoff, R. Belcher, V. A. Stenger and G. Matsuyama. Interscience, New York, 1957. ix + 714 pp. $15.

This long-awaited volume completes the three-volume series on volumetric analysis by Kolthoff and his associates. Volume I, *Theoretical Fundamentals,* was issued in 1942 and volume II, *Titration Methods: Acid-Base, Precipitation, and Complex-Formation Reactions,* was issued in 1947. The third volume is of the same high quality as the

earlier works and is an outstanding contribution to analytical literature.

The subject matter is presented in 14 chapters. The initial chapter on reactions, indicators, and general techniques is followed by chapters on potassium permanganate as both a volumetric and an oxidimetric reagent employed in methods for the determination of many inorganic and organic substances. Similar chapters cover the oxidimetry and use of ceric salts, potassium dichromate, iodine, iodates, periodates (Malaprade reaction), bromates, and hypohalites. In addition, there are chapters on the determination of water with the Karl Fischer reagent and on miscellaneous oxidizing and reducing titrants—for example, ferric salts and arsenious oxide.

The text material is up to date and is presented in the clear, orderly style characteristic of the senior author and his associates. The book is well-indexed. Cross references throughout the text will enable the reader to pin-point desired information readily—a very useful aid to those searching for reliable and thorough information when carrying on analytical operations. The student, teacher, and experienced chemist will find a great amount of information in this text with which their objectives can be more quickly and easily attained.

H. A. BRIGHT
National Bureau of Standards

Studies on Fossil Vertebrates. Presented to David Meredith Seares Watson. T. Stanley Westoll, Ed. University of London, Athlone Press; Essential Books, Fair Lawn, N.J., 1958. xii + 263 pp. Illus. $5.60.

This series of papers, honoring D. M. S. Watson on his retirement from the University of London, includes interesting, authoritative, and well-written theoretical studies, review articles, and discussions of new material in many of the fields Watson himself investigated.

Five chapters deal with fossil fish. Dorothy H. Rayner discusses the problems in determining the life habitats of fossil fish. Fish remains are very rare in modern dredging except in areas of low oxygen content, which suggests that the abundance of fossil fish in any environment may be inversely related to their abundance as living fish.

Errol I. White concludes that the evidence indicates that the original home of the craniates or Vertebrata was salt water, not fresh. Evidence for a freshwater origin often involves fish which lived in fresh water at some unspecified time after their origin, but this has no bearing on where the origin actually was. Perhaps the problem is complicated by there being no universally accepted definition of the precise point at which organisms became vertebrates. White cites zoological, geologic, and paleogeographic evidence, indicating that craniate conditions were achieved in marine (presumably coastal) waters, though the vertebrates may soon have entered fresh water.

T. S. Westoll concludes that, in early fishes, there was probably never "an ancestral type with continuous paired finfolds with segmented endoskeleton and segmental muscles," but that "there was a paired line of potential skin-folding, from which keel-like structures could develop," and that such structures developed several times among the early vertebrates, the invasion by muscles being independent in the different groups. The general homology of paired fins is indicated by the similarity of blood supply and innervation in the cephalaspids and sharks.

A new restoration of *Lasanius* accompanies F. R. Parrington's discussion of the Anaspida. Resemblances to cyclostomes are striking, suggesting the presence of similar gill sacs. These organisms probably buried their heads in the mud for feeding and pumped water in and out of the gill pouches for respiration.

The head of another anaspid, *Birkenia,* is restored by Anatol Heintz, who believes that the mouth and feeding habits were like those of *Amphioxus* rather than of cyclostomes.

Three papers summarize important aspects of the evolution of higher vertebrates: the stratigraphy, fauna, and environment of the Texas Permian, by A. S. Romer; evolutionary trends among Triassic tetrapods and indications of the similarity of Triassic and Cretaceous extinctions, by Edwin H. Colbert; and annotated faunal lists of the fossil vertebrates of Australia, which, E. Sherborn Hills states, show that Australia has always had closer faunal relationships with Europe than with South America or Africa.

The remaining three chapters are more theoretical. Causation in evolution, correlation of structure and function, relationships of internal and external environment, and evolutionary rates and directions are discussed by W. K. Gregory, Sir Gavin de Beer and W. E. Swinton stress paedomorphism (that is, the younger stages of the ancestor prophesy the adult stages of the descendant) in fossil sequences, both vertebrate and invertebrate. The neo-Darwinian basis of major evolutionary changes is questioned by James Brough, who feels that families and smaller units may arise by natural selection but that orders and higher groups have arisen very rapidly, due both to a former much higher mutation rate and to directional mutations. He observes that no new animal phyla have arisen since the Cambrian, and no new classes (except birds and mammals) since the Paleozoic, and concludes that "evolution is almost or quite spent as a major creative force."

ALBERT E. WOOD
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Quantum Mechanics. Non-relativistic theory. L. D. Landau and E. M. Lifshitz. vol. 3, of *Course of Theoretical Physics.* Translated by J. B. Sykes and J. S. Bell. Pergamon Press, London; Addison Wesley, Reading, Mass., 1958. xii + 515 pp. $12.50.

This volume is the second to appear in a projected series of nine volumes on theoretical physics by these authors. It is in many ways an excellent introduction to the ideas and the applications to atomic phenomena of nonrelativistic quantum mechanics.

The strong point of this text is the completeness with which it treats atomic problems. There is an almost exhaustive discussion of angular momentum and spin on an elemenatry level. Of particular interest are the detailed computations of matrix elements for angular momentum problems and the introduction and use of spinors in the discussion. The treatment of the semiclassical (Wentzel-Kramer-Brillouin) approximation is far more detailed and interesting than that given in comparable available texts and includes, for example, a little-known calculation by Landau of the matrix elements in this approximation.

It is difficult to show restraint in praising the chapters on elementary many-body systems. Besides the usual self-consistent field analysis, a good account is given of the Thomas-Fermi model of the atom. Following these more or less general methods there is a long exposition of results for the diatomic molecule. The chapter on polyatomic molecules is preceded by a very readable introduction to the theory of groups, particularly as it relates to the representation of molecular symmetry. These ideas are then applied in discussion of the vibrational properties of the polyatomic molecule.

The concluding chapters are devoted to the theory of scattering, both elastic and inelastic. The authors make very effective use of the semiclassical approximation in scattering problems. They make mention of the Gelfand-Levitan recipe for deriving the potential energy from the phase shifts but do little more than quote it.

It seems to me that this text is not as good as many now available as a general

introduction to the ideas (as opposed to the methods) of quantum mechanics. The general introduction to quantum mechanical ideas is often *ad hoc* and might be incomprehensible to the student without understanding of the historical background which led to wave mechanics.

In short, this book is an excellent reference for those interested in atomic physics but requires a good deal of supplementary material if used in an introductory course in quantum mechanics.

GEORGE H. WEISS
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Six Days or Forever? Tennessee vs. John Thomas Scopes. Ray Ginger. Beacon Press, Boston, 1958. 258 pp. $3.95.

This book is a complete historical account of the notorious "monkey trial" in Dayton, Tennessee, in 1925; it includes, also, a biographical sketch of each of the principal actors—the judge, the author of the antievolution law, Scopes, Bryan, Darrow, and many other public figures involved in one way or another; still further, there is a thoughtful analysis of the influence of world events on public thinking and of the factors motivating the various personalities. The major immediate facts and events were brought to everyone at the time by public press and radio; the sequence and background have never before been portrayed in full.

After a third of a century, dispassionate judgment brings the sober conviction that everyone behaved very badly; after all, it was an event without precedent in the experience of anyone in public life at the time. And one must now realize that the trial was but a symbol of something not immediately apparent then—something that was neither secular, regional, nor political, an eruption of an element ever-present in any population, but, fortunately, suppressed most of the time. Recent world events had upset the balances that usually temper violent fanaticism. Efforts at restrictive legislation appeared, north, south, east, and west—sometimes succeeding, sometimes failing, taking varied forms, but almost invariably compounded of the same basic ingredients: prohibition, antievolution, antitobacco, antifeminism, antisuffrage, antivaccination, antitransfusion, antihairbob, anti-Teutonism.

Several states still retain restrictive laws of one kind or another enacted during the period between World War I and the onset of the depression. The spirit was rampant, and the fact that repeals have not been more general suggests that the present dormancy could evaporate quickly. One ardent zealot in New York was busily inveighing against medicine while another in Illinois wanted the earth made flat by legislative fiat. In Indiana, a little earlier, the legislature decreed that the value of pi should be fixed at 4! Another reason for the quiescent phase of antievolution is that canny politicians, always sensitive to ridicule, sidestep the issue by way of textbook commissions, whose members are always political appointees and have absolute authority to reject textbooks not meeting the requirements adopted by the commissions themselves and seldom subject to review by any authoritative agency.

Representative John W. Butler introduced the bill in Tennessee which was enacted into law when political expediency smothered opposition. Bryan suggested, just as a psychological compromise, that no penalty clause be attached to the measure. Some legislators voted for passage because they thought (as claimed later) that Governor Peay would veto the bill as a matter of course. He, however, said the bill was absurd and that the legislature had no right to pass on to him the onus of decision. Political demands prompted him to rationalize. He was reelected. Law-enforcement agencies generally ignored the Butler act until the American Civil Liberties Union took note and decided on a test case (but failed at first to find anyone willing to file a complaint). Genuine religious zeal, civic promotion, and political opportunism combined to initiate the next step, when a New York born mining engineer operating in Dayton persuaded John T. Scopes, a naive young high-school science teacher, to be a test subject. He acknowledged guilt and was bound over to the grand jury. Ironically, he admitted later that on the specific day named in the indictment he was absent from school and did not actually teach anything about evolution at all.

As legal formality, the trial was a farce. Bryan volunteered his services as council for the prosecution, although he had not tried a case in 30 years. There was considerable local resentment at this unnecessary intrusion into a case which was an open-and-shut minor legal episode. The law was clear, and Scopes's guilt was admitted. Such a case would not, ordinarily, call for a jury trial; nor would a defendent ordinarily need to import council. The Civil Liberties Union persuaded Clarence Darrow to lend his services, along with other distinguished legal lights. His dominant pesonality more or less overshadowed the others. He was inexcusably insulting at times, and just as dogmatically fanatical as Bryan. He did, despite that, conduct a brilliant defense, the highlight of which came when he forced Bryan onto the witness stand, where, for the first time in his life, Bryan was obliged to answer questions. Bryan's whole thesis collapsed, and he left the stand an object of pity to his more staunch supporters, of contempt to those who had expected him to demolish the atheist lawyer from Chicago. The constitutionality of the law was not affected by the trial.

Bryan had been an antievolutionist for many years but, shrewd politician that he was, he did not openly declare himself until he was sure that the fundamentalist crusade was strong enough to furnish a "cause" for a public figure badly in need of one. He seldom endorsed any move until he was sure it had gathered enough momentum to carry him along on the crest of the wave.

As a biologist engaged in teaching during those years, I recall vividly the ingenious methods adopted by many teachers for saying "evolution" without letting red-hot zealots know that was what they were saying. Today, those of more recent vintage may regard those situations with amusement, but the sobering realization is ever present in the minds of those who shivered through class sessions with glowering critics listening in for something that might stamp the lecturer as an evolutionist that such a wave of fanaticism could yet sweep up a holocaust of disastrous proportions. Only three years ago, two students in one of our largest medical schools announced to one of their professors that they were antievolutionists and members of a large and powerful group which could, and would, be very influential if it decided to become vociferous.

Every scientist inclined to smugness needs to read this book in a serious mood and then pledge himself to avoid the error of his predecessors in allowing the antievolution movement to creep up because they were overconfident of their own positions in society and never troubled to translate their convictions into terms that the public could comprehend. Many potential scientists were deterred from risking careers in science by this trial and other related events of the period.

C. I. REED
Greensboro, North Carolina

The Motility of Muscle and Cells. Hans H. Weber. Harvard University Press, Cambridge, 1958. 69 pp. $3.50.

This attractive little booklet contains the three Dunham lectures delivered at Harvard University in March 1957. The first of the three chapters, containing the first lecture, deals with the chemical factors producing contraction and relaxation in the muscle fiber. The factors considered in detail are the relaxing factor

contained in the granules ("Marsh factor"), adenosine triphosphate, and calcium and magnesium ions. Adenosine triphosphate has two functions: In rest it renders the muscle plastic and extensible, while in activity it makes the muscle contract, supplying it with energy by means of the splitting of its terminal high-energy phosphate bond. During contraction, Mg^{++} activates actomyosin, while in relaxation it activates the relaxing factor. In rest, Ca^{++} is bound to actomyosin, while it inactivates the relaxing factor during contraction. Major significance is attributed to the alternate binding and release of these two ions on the two sites in the chemical mechanism of contraction and relaxation.

The second chapter deals with the mechanism of muscular contraction. The author shows the inadequacy of earlier theories and takes sides with the "sliding theory," for which he offers a detailed chemical interpretation.

In the third chapter Weber deals with "the four mechanisms involved in the movement of cells." He shows that the mechanism of contraction found in muscle underlays various forms of motion in diverse cells but represents in no way the only mechanism found in nature. "Nature apparently made experiments with different mechanisms of movements," such as stretching and contraction of organelles by Ca^{++}, prevented or reversed by adenosine triphosphate, and stretching induced by adenosine triphosphate and other polyphosphates.

Not all researchers in this field will necessarily subscribe to Weber's views on all points. But even if the views expressed are at many points individual ones, they are interesting, Weber being one of the leading pioneers of muscle research. The personal touch makes the little book refreshing and interesting reading.

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Handbuch der Physik. vol. 5, pt. 1, *Principles of Quantum Theory.* S. Flügge, Ed. Springer, Berlin, 1958. 376 pp. Illus. DM. 90.

This volume of the *Handbuch* contains two articles. *"Die allgemeinen Principien der Wellenmechanik,"* by W. Pauli, is largely a reprint of an article that appeared in the previous (1933) edition; "Quantenelektrodynamik," by G. Källén, contains subject matter that, on the average, is less than a decade old.

Pauli's work remains a classic account of both wave and matrix mechanics for systems with a finite number of degrees of freedom. The deletion of the final sections, which contained a now inadequate introduction to, and critique of, quantum electrodynamics, is the only noteworthy change from the prior version. Because of the undiminished luster of the author's reputation, and because of the intrinsic virtues of the article, it will continue to attract serious students of quantum mechanics who wish to deepen their understanding of the subject beyond what is offered in the usual first course.

In the article on quantum electrodynamics, G. Källén describes the most impressive achievement of theoretical physics of the last decade. This has been the development of the theory of renormalization and its application to the interaction of the Maxwell field with the electron-positron field, permitting the extraction, from a mathematically meaningless theory, of physical predictions which have had a striking experimental confirmation. The account of the interaction of the two fields, the central theme of the work, is strongly influenced by the author's own contributions to the subject: a most careful application of the adiabatic hypothesis to the discussion of scattering processes and an early realization of the superiority of the Heisenberg picture (representation) for the definition of the concept of physical particle.

Nevertheless, the deduction of physical results follows well-established lines. The Dyson form of the S-matrix is developed briefly and applied to the simplest scattering processes. The discussion of the so-called radiative corrections, which embrace the new practical achievements of theory, is carried through by means of an effective current operator—almost the earliest satisfactory method applied to these problems—but the detailed calculations are simplified considerably by the fullest use of those analytic properties of the theory which follow from its "causal" character. The concepts of charge and mass renormalization are introduced, and such decisive tests of the theory as the corrections to the scattering of an electron by a Coulomb field, the anomalous electron moment, the Lamb shift and the hyperfine structure of hydrogen-like atoms, and the fine structure of positronium are calculated to lowest order. The results of higher order calculations are summarized, and the striking agreement with experiment is indicated.

The article concludes with a detailed presentation of the author's own most basic contribution to the subject, the development of a general theory of renormalization of mass and charge without the use of perturbation theory and his so far inconclusive attempt to establish the mathematical *inconsistency* of the renormalization theory.

The only conspicuous omissions from Källén's painstakingly constructed article are an account of Dyson's classic proof of the renormalizability of the S-matrix and the current postulational studies of the general structure of the theory along the lines laid out in part by the author himself. Presumably the latter will loom large in the so far elusive part 2 of this volume.

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Proceedings of the International Symposium on Isotope Separation. Held in Amsterdam, 23–27 Apr. 1957. J. Kistemaker, J. Bigeleisen, A. O. C. Nier, Eds. North-Holland, Amsterdam; Interscience, New York, 1958. xx + 704 pp. Illus. $15.

Although the separation of isotopes has been of increasing interest in the last two decades, the first broad international conference in this field was held in Amsterdam in April 1957.

The papers presented there have been compiled into an excellent reference volume, nicely balanced between theory and practice. Many of those most actively engaged in isotope separation are among the contributors. Sixty-three papers are included; most of them are in English, a few are in French and German. At least 14 nations are represented.

This book is conveniently arranged in nine parts, as follows: "Chemical engineering" (four papers pertaining to plant processes); "Molecular interactions" (four papers on isotope effects); "Chemical exchange" (ten papers); "Electromigration" (six papers); "Distillation" (seven papers); "Thermal diffusion" (seven papers); "Diffusion" (nine papers); "Electromagnetic separation" (11 papers, two abstracts); and "Ultracentrifuges" (two papers).

Chemical exchange and electromagnetic separation receive the most attention, as would be expected, considering the success of these methods in producing a variety of useful quantities of isotopes. Workers on these methods have extended wartime progress, to the benefit of isotope separation and isotope application.

However, this comment is not intended to take any credit from the excellent original research done and reported in this book on other methods of isotope separation. It is good that this conference covered all methods so well.

Much progress has been made in the gaseous diffusion process, but security classification continues to obscure most of this technology.

This volume will be happily received by all those interested in or engaged in isotope separation. Such a complete com-

pilation of papers in this area may not appear again for many years.

The entire volume is well arranged and remarkably free from errors, in view of the number and geographical distribution of the contributors.

J. Kistemaker, the force behind the conference and in the preparation of these proceedings, has performed a valuable service for his colleagues.

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Progress in the Chemistry of Organic Natural Products. vol. XIV. L. Zechmeister, Ed. Springer, Vienna, Austria, 1957. viii + 377 pp. $17.85.

In this most recent volume of the *Progress* series, Zechmeister has assembled seven chapters representative of fields of current interest; five of these deal with the chemistry of plant materials. Noteworthy is the steady increase in the amount of space devoted to biogenetic mechanisms—no longer an isolated area of fragile speculation.

"Acetylenverbindungen im Pflanzenreich," by F. Bohlmann and H. J. Mannhardt, reviews the methods of isolation, structure elucidation, and synthesis of a variety of acetylenes and polyacetylenes found in both higher and lower plants. The chapter closes with a detailed speculation on the biogenesis of this series and a description of the use of actylene compounds as a guide in plant taxonomy.

In "Neuere Ergebnisse auf dem Gebiete der glykosidischen Herzgifte: Zucker und Glykoside," C. Tamm presents recent work on the chemistry of the cardiac-active glycosides. Physical properties of the sugars and aglycones, as well as botanical sources of the glycosides, are presented in extensive tables.

The chemistry of hypericin and related polycyclic quinones is set forth in a chapter by H. Brockmann, "Photodynamisch wirksame Pflanzenfarbstoffe." These plant coloring matters sensitize grazing animals to serious irritation by sunlight. The interesting hypothesis that such compounds catalyze the photooxidation of proteins is discussed briefly.

In "Biosynthetic relations of some natural phenolic and enolic compounds," A. J. Birch summarizes the evidence derived from labeling and other experiments which permits an elaboration of the pathway from two-carbon fragments to complex cyclic compounds. By making use of a few chemical reactions known to be within the realm of enzymes, Birch is able to correlate the structures and biosynthesis of a wide variety of natural products, including phenols, coumarins, anthocyanins, lignin precursors, terpenoids, and tropolones.

H. Sobotka, N. Barsel, and J. D. Chanley have reviewed the chemistry, physiology, and pharmacology of "The aminochromes." The oxidation products of phenylethylamines have long been of interest as precursors of melanin pigments. The current research activity on the metabolism of adrenalin and aromatic amino acids, and on the pharmacological properties of these unstable quinones themselves, renders the chapter particularly timely.

A portion of the complex and fascinating chemistry of vision is reviewed in "Visual pigments," by R. A. Morton and G. A. J. Pitt. In addition to describing the chemistry of retinenes and rhodopsin, the authors have enhanced the value of the review by including a comparative survey of the eye pigments of nonmammalian species.

A final chapter by H. Brown, "The carbon cycle in nature," discusses the possible origins and the quantities, rates, and mechanisms of turnover of biochemical carbon. A number of phenomena are explained by the assumption that the earth was born with a reducing atmosphere which was gradually transformed to the present oxidizing atmosphere.

The high calibre of writing traditional to this series is maintained in the present volume, as is the quality of the paper and printing.

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British Pharmacopoeia, 1958. Published under the direction of the General Medical Council. Pharmaceutical Press, London, for the Council, 1958 (order from Rittenhouse Bookstore, Philadelphia). xxvi + 1012 pp. £3 3s.

American readers familiar with the *United States Pharmacopeia* (*USP*), volume XV, will be perfectly at home with the *British Pharmacopoeia, 1958* (*BP*). The two compendia are similar in scope, content, and format. Both consist of introductory notices and definitions, several hundred pages of monographs running from acacia to zinc undecylenate (including names, descriptions, identification and assay methods, and the like), and detailed appendices on methods and materials. In both books the material is assembled with the assistance of committees drawn from pharmacists and physicians from universities and industry; the English use about twice as many committees as do the Americans.

A few of the minor differences may be interesting to American readers. The *BP* eliminates the salt of a drug when only one form is used; thus "Injection of neostigmine methylsulfate" becomes "Neostigmine injection." In expressing dosage the *BP* is somewhat less consistent than the *USP*. Some statements are brief, as for isoniazid: "0.1 to 0.3 g. daily in divided doses"; others are long, as for cyanocobalamin: "By intramuscular injection, controlling dose, 50 to 100 micrograms weekly, or more frequently if subacuate combined degeneration of the spinal cord is present; maintenance dose, 50 to 100 micrograms every two or three weeks." In the *USP* the usual dose and the range of doses are given separately, with therapeutic directions uniformly brief. A more important difference is the inclusion of a categorizing name or statement in the *USP* which informs the reader of the general action or type of the drug, and thus helps to identify a drug when its name alone does not bring recognition.

Neither book is a therapeutic guide for physicians. Rather both are books of standards and sources of pharmaceutical directions which list officially those drugs preferred in good medical practice.

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New Books

Administrative Medicine. Transactions of the fifth conference, 28–30 October 1956, Princeton, N.J., George S. Stevenson, Ed. Josiah Macy, Jr. Foundation, New York, 1958. 197 pp. $3.75.

Advances in Clinical Chemistry. vol. I. Harry Sobotka and C. P. Stewart. Academic Press, New York, 1958. 409 pp. $12.

Adventures in the World of Science. Charles Greeley Abbot. Public Affairs Press, Washington, 1958. 159 pp. $3.50.

Aircraft Communications Systems. J. H. H. Grover. Philosophical Library, New York, 1958. 135 pp. $6.

Bacterial and Mycotic Infections of Man. Rene J. Dubos. Lippincott, Philadelphia, ed. 3, 1958. 832 pp. $8.50.

The Biological Replication of Macromolecules. Symposia of the Society for Experimental Biology, No. XII. Academic Press, New York, 1958. 261 pp. $9.50.

Buildings for Research. An architectural record book. F. W. Dodge Corp., New York, 1958. 224 pp. $9.50.

Causes de la répartition des êtres vivants. Raymond Furon. Masson, Paris, 1958. 168 pp. Paper, F. 1000.

Clinical Neuroanatomy, Neurophysiology, and Neurology. With a method of brain reconstruction. Louis Hausman. Thomas, Springfield, Ill., 1958. 547 pp. $9.75.

Coccidioidomysocis. Marshall J. Fiese. Thomas, Springfield, Ill., 1958. 253 pp. $9.50.

Cosmic Electrodynamics. J. W. Dungey. Cambridge Univ. Press, New York, 1958. 192 pp. $6.

Discussions on Child Development. A consideration of the biological, psycho-

logical, and cultural approaches to the understanding of human development and behavior. vol. 3. Proceedings of the third meeting of the World Health Organization Study Group on the Psychobiological Development of the Child, Geneva, 1955. J. M. Tanner and Bärbel Injelder, Eds. International Universities Press, New York, 1958. 223 pp. $5.

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The Gang. A study in adolescent behavior. Herbert A. Bloch and Arthur Niederhoffer. Philosophical Library, New York, 1958. 246 pp. $6.

Gas Chromatography. A symposium held under the auspices of the Analysis Instrumentation Division of the Instrument Society of America, August 1957. Vincent J. Coates, Henry J. Noebels, Irving S. Fagerson, Eds. Academic Press, New York, ed. 2, 1958. 335 pp. $10.

Getting Acquainted with Minerals. George Letchworth English and David E. Jensen. McGraw-Hill, New York, ed. 2, 1958. 372 pp. $6.95.

Modern Geometrical Optics. Max Herzberger. Interscience, New York, 1958. 516 pp. $15.

Numerical Mathematical Analysis. James B. Scarborough. Johns Hopkins Press, Baltimore; Oxford Univ. Press, London, ed. 4, 1958. 597 pp. $6.

Peace without Victory. Woodrow Wilson and the British liberals. Laurence W. Martin. Yale Univ. Press, New Haven, Conn., 1958. 241 pp. $4.50.

Perception and Communication. D. E. Broadbent. Pergamon, New York and London, 1958. 338 pp. $8.50.

Pictorial History of Israel. Jacob A. Rubin and Meyer Barkai. Yoseloff, New York, 1958. 319 pp. $7.50.

The Practical Use of the Microscope, Including Photomicrography. George Herbert Needham. Thomas, Springfield, Ill., 1958. 517 pp. $15.50.

Radiation Protection. Carl B. Braestrup and Harold O. Wyckoff. Thomas, Springfield, Ill., 1958. 380 pp. $10.50.

Recent Progress in Hormone Research. Proceedings of the Laurentian Hormone Conference 1957. vol. XIV. Gregory Pincus, Ed. Academic Press, New York, 1958. 590 pp. $13.50.

Revelation through Reason. Religion in the light of science and philosophy. Errol E. Harris. Yale Univ. Press, New Haven, Conn., 1958. 170 pp. $4.50.

Semimicro Experimental Organic Chemistry. A laboratory manual. Nicholas D. Cheronis. de Graff, New York, 1958. 416 pp. $5.50.

Science and the Idea of God. C. A. Coulson. Cambridge Univ. Press, New York, 1958. 51 pp. $0.90.

The Social History of Lighting. William T. O'Dea. Macmillan, New York, 1958. 267 pp. $8.50.

Social Psychiatry in Action. A therapeutic community. Harry A. Wilmer. Thomas, Springfield, Ill., 1958. 396 pp. $8.75.

Technical Education and Social Change. Stephen F. Cotgrove. Allen & Unwin, London; Essential Books, Fair Lawn, N.J., 1958. 220 pp. $4.50.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

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Sistema fonémico del macoíta. Lenguas indigenas de Venezuela, No. 1. Martha Hildebrandt. Comisión Indigenista, Ministerio de Justicia, Caracas, Venezuela, 1958. 99 pp.

L'Institut national pour l'etude agronomique du Congo Belge. vol. VII, No. 2. L'Institute, rue Defacqz, 1, Brussels, Belgium, 1958. 61 pp.

Les Observations météorologiques en Terre Adélie 1950–1952. Analyse critique. Expéditions polaires francaises; expéditions Antarctiques, résultats scientifiques. André Prudhomme and Bernard Valtat. 1957. 180 pp.

Climatologie de Paris et de la région parisienne. Mémorial de la météorologie nationale. No. 45. H. Grisellet. 1958. 78 pp. Secretariat Général à l'Aviation Civile et Commerciale, 1, Quai Branly, Paris.

Ceylon Association for the Advancement of Science. Thirteenth annual session, 19–21 December, 1957. *General Programme, Annual Reports,* 42 pp.; *Proceedings,* pts. 1 and 2, 230 pp. Ceylon Assoc. for the Advancement of Science, Univ. of Ceylon, Colombo 3.

An Alphabetical List of Plant Species Cultivated in the Hortus Botanicus Bogoriensis. Foundation for Nature Research, Botanic Gardens of Indonesia and Council for Sciences of Indonesia, Djakarta, Indonesia, 1958. 266 pp.

Anuario bibliografico peruano de 1951–1952. Alberto Tauro. Ediciones de la Biblioteca Nacional, Lima, 1957. 436 pp.

The Determination of the ABO and Rh(D) Blood Groups for Transfusion. Medical Research Council Memorandum No. 36 (Revision of War Memorandum No. 9). Her Majesty's Stationery Office, London, 1958. 46 pp. 3s. 6d.

Proceedings of the Royal Institution of Great Britain. Containing accounts of the Friday evening discourses and other meetings. vol. 37, pt. 1, No. 165, 1958. Royal Institution, London, 1958. 118 pp. 8s. 6d.

The Mealy-Bugs (Pseudococcidae: Homoptera) Described by W. J. Hall, F. Laing and A. H. Strickland from the Ethiopian Region. Bulletin, Entomology, vol. 7, No. 1. D. J. Williams. British Museum (Natural History), London, 1958. 37 pp. 10s.

The Institute of Medical and Veterinary Science. Nineteenth Annual Report of the Council, July 1956–June 1957. The Institute, Adelaide, Australia, 1958. 79 pp.

Commonwealth Scientific and Industrial Research, Ninth Annual Report, 1956–57. Parliament of the Commonwealth of Australia, Canberra, Australia, 1958. 179 pp. 10s. 6d.

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Deep-Sea Echinoderms of New Zealand. Zoology Publ. No. 24. H. Barraclough Fell. Victoria Univ., Wellington, New Zealand, 1958. 40 pp.

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Oceanographic Papers in Japan. Annotated bibliography, 1939–1957. vol. II. 217 pp. *Records of Oceanographic Works in Japan.* Spec. No. 2 for the Oceanographic Research Project by the Japanese National Commission for UNESCO. A continuation of the *Records of Oceanographic Works in Japan,* vol. 12, No. 2. Compiled by Pacific Science Liaison Committee of Science Council of Japan. 242 pp. Japanese National Commission for UNESCO, 4-3 Kasumigaseki, Chiyoda-ku, Tokyo, Japan, 1958.

Safe Handling of Bodies Containing Radioactive Isotopes. A guide for surgeons, pathologists, and funeral directors. Handbook 65. National Bureau of Standards, Washington 25, 1958 (order from Supt. of Documents, GPO, Washington 25). 22 pp. $0.15.

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Reports

Approximation to a Gravity-Free Situation for the Human Organism Achievable at Moderate Expense

So far as their effects on the human organism are concerned, the chief peculiarities of weightlessness consist in (i) the cessation of unidirectional stimulation of the vestibular system, together with the sequelae accruing therefrom through reactions of the autonomic and central nervous systems, and (ii) the letting up of the hydrostatic drag on the circulatory system, especially that associated with the erect posture of man. Both of these peculiarities can be approximated to a considerable degree by a combination of relatively simple devices. The use of these would enable data on the effects of this pseudo-weightlessness, maintained for several hours at least, to be obtained long before the still exceedingly costly direct tests of subjecting human beings to prolonged free fall can be carried out by Western scientists.

By far the greater portion of the hydrostatic drag is absent in human beings whose body axis is in a horizontal position, as it is when they are recumbent. Most of the remainder can be evened out and in effect nullified by subjecting them to a moderate spinning motion about their horizontal axis, through the automatic rotation of a cylinder within which they are held. At the same time, little sense of the pressure caused by their body weight would remain if the body, including the limbs, were encased in a skin-tight envelope, and held immersed in a brine having the same specific gravity as the average for the body itself.

Considerable freedom of movement can be allowed for the limbs. The head can be encased in a transparent helmet that is serviced for respiration and oral communication. It is to be held with its axis in alignment with the body axis. That is, the head is not permitted tilting movements that would set its axis at an angle to that of the body; however, it is left free to carry out any desired voluntary movements of rotation on its axis. A field of view, imitative of furnishings and, for example, of a window showing a skyscape, would be arranged that remained in a fixed position with reference to the subject. Thus the field of view would spin together with the subject himself, and the subject would lack the visual stimuli associated with an imposed rotary movement.

The subject, after having been fastened within the cylinder, would at first be at rest but by insensible degrees would be subjected to a rotary movement about his horizontal axis, at a speed that increased until it attained the psychophysiological optimum for disengaging his vestibular apparatus from an effective pull by gravity in any given direction. Thereafter the motion is to be kept smooth and steady. Preliminary experiments have shown that under such circumstances, so long as the subject's head remains with its original relation to the body axis, he soon becomes quite unaware of the rotary movement as such. This is because the fluid in his semicircular canals has come to rest, in relation to their walls (except for any voluntary axial turning movements, which then give rise only to the effects usual for them), and because he has no notification of the imposed rotation through vision and very little through skin or internal bodily pressures.

It is likely that a suitable speed of rotation could be found which was too fast, in relation to the sensitivity of that part of the vestibular apparatus which detects translational (linear) acceleration or gravity in any one direction, to allow such stimuli to accumulate to an appreciable degree. That is, not so rapid a periodicity should be required to transcend "flicker" in the case of the sensation of linear acceleration here in question as in the case of optical flashes. For psychological and physiological purposes, a condition approximating that of weightlessness or free fall would thereby have been achieved. Essentially the same mechanism has long been used for nullifying gravity in studies on plants, but the speed of rotation for this apparatus, called a clinostat, can be much slower because of the much slower reactivity of plant tissues.

Among other questions that would thereby be opened for investigation are those concerned with the effects, on free-fall tolerance, of individual differences (as between persons of differing tendencies to become giddy or motion-sick) and of the effects of differing physiological conditions and of diverse drugs (such as those used against motion sickness). The relatively small cost of the apparatus required for such experiments, and the relatively short time required for its construction, recommend it for pilot studies on the effects of fairly prolonged weightlessness (*1*).

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Note

1. This report is based upon a paper read at Symposium on Possible Uses of Earth Satellites for Life-Sciences Experiments, Washington, D.C., 17 May 1958; Contribution No. 659 of Zoology Department, Indiana University.

21 May 1958

Role of Somatotropin in Mammogenesis and Lactogenesis in C3H/He CRGL Mice

In mammary gland growth and differentiation in rodents, mammotropin with ovarian steroids induces lobulo-alveolar development, and if this is followed by treatment with mammotropin and adrenocortical steroids, lactogenesis will result (*1*). Somatotropin (hypophysial growth hormone) synergizes in both these cases to enhance the action of the hormonal combinations (*2, 3*); however, somatotropin has not been reported to act either as a lobulo-alveolar mammogen or as a lactogen in the absence of mammotropin.

Recently it was shown that a purified somatotropin preparation (containing 0.5 to 2 percent mammotropin) acts alone as a duct mammogen in hypophysectomized rats (*1*). Ferguson (*4*) observed that this hormone by itself had no direct mammogenic action in hypophysectomized C3H mice but that the formation of terminal buds and some alveoli was induced by treatment with somatotropin, estradiol, and progesterone. The present report is concerned with the role of somatotropin in mammogenesis and lactogenesis in C3H/He CRGL mice. These experiments are part of a larger study dealing with the endocrine con-

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper. (Since this requirement has only recently gone into effect, not all reports that are now being published as yet observe it.)

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* 125, 16 (1957)].

trol of mammary growth and function in this strain of mouse (*5*).

Pituitaries, ovaries, and adrenals were removed (triply operated) from 3-month-old virgin C3H/He CRGL females. The animals were then treated for 15 to 20 days with various combinations of ovarian and adrenocortical steroids together with somatotropin, administered in daily subcutaneous injections. The steroids were prepared as aqueous suspensions, and unless otherwise indicated, the following daily doses were used: β-estradiol, 1 μg; progesterone, 1 mg; deoxycorticosterone acetate, 0.2 mg; cortisol acetate, 125 μg. Various amounts of bovine somatotropin (15 μg to 1 mg), dissolved in water at *p*H 8.0 to 8.5, were also administered daily. At the end of each experiment, the mammary glands were removed, fixed in 10 percent formalin, stained with iron-hematoxylin, cleared, and stored in methyl salicylate. These preparations were examined under a dissecting microscope, after which representative areas were taken for histologic study.

The mammary glands of normal 3-month-old virgin females usually contain only medium and wide ducts and terminal buds of various sizes. Occasionally, a few alveoli and alveolar buds are also present. Removal of pituitaries, ovaries, and adrenals results in regression of the finer branches and terminal buds within 15 days (Fig. 1, *A*).

Two hormonal regimens, involving somatotropin, given for 20 days, were found to stimulate the duct system in triply operated mice beyond the level of development seen in 3-month-old controls: Daily administration of 0.5 mg of somatotropin, along with estradiol and deoxycorticosterone acetate, or along with estradiol, deoxycorticosterone acetate, and 62.5 μg of cortisol acetate, resulted in comparable degrees of duct stimulation (Fig. 1, *B*).

Somatotropin, along with estradiol and progesterone, was found to induce lobulo-alveolar development in triply operated mice. Treatment with estradiol, progesterone, and 15 μg of somatotropin per day for 15 days resulted in the formation of a few alveoli. When the level of somatotropin was increased to 100 μg/day, large numbers of alveoli, some organized into lobules, were found. Increase of somatotropin dosage to 1 mg/day resulted in lobulo-alveolar development similar to that of intact females at midpregnancy. This lobulo-alveolar development was at least as extensive as that obtained with estradiol, progesterone, and 1 mg of mammotropin per day (*5*).

Lactogenesis was induced in triply operated females by daily injections of estradiol, progesterone, and 1 mg of somatotropin for 15 days, followed by daily injections of cortisol acetate and 1 mg of somatotropin for 5 days. Glands from mice treated in this way were composed of lobules filled with milk (Fig. 1, *C*), and the secretion-filled alveolar lumina were partially lined with vacuolated cells (Fig. 1, *D*), such as are found in the normal lactating mammary gland. These results are similar to those obtained experimentally when mammotropin is used in place of somatotropin (*5*).

Additional experiments eliminate other possible explanations for the observed effects of somatotropin: (i) A mouse placentoma assay indicated the presence of 0.5 to 1.0 percent mammotropin in our somatotropin preparation. Neither lobulo-alveolar development nor lactogenesis was induced in triply operated mice when the somatotropin was replaced by small amounts (15 μg/day) of mammotropin, indicating that the results obtained with our somatotropin preparation could not be ascribed to the small quantity of mammotropin present as a contaminant. (ii) Serial sections of operated areas from the skulls of representative triply operated animals showed no residual pituitary tissue, thus excluding the possibility that such remnants might be secreting hormones that could synergize with the exogenous somatotropin. (iii) Mice hypophysectomized and ovariectomized 20 to 25 days before initiation of treatment showed the same responses as those treated immediately

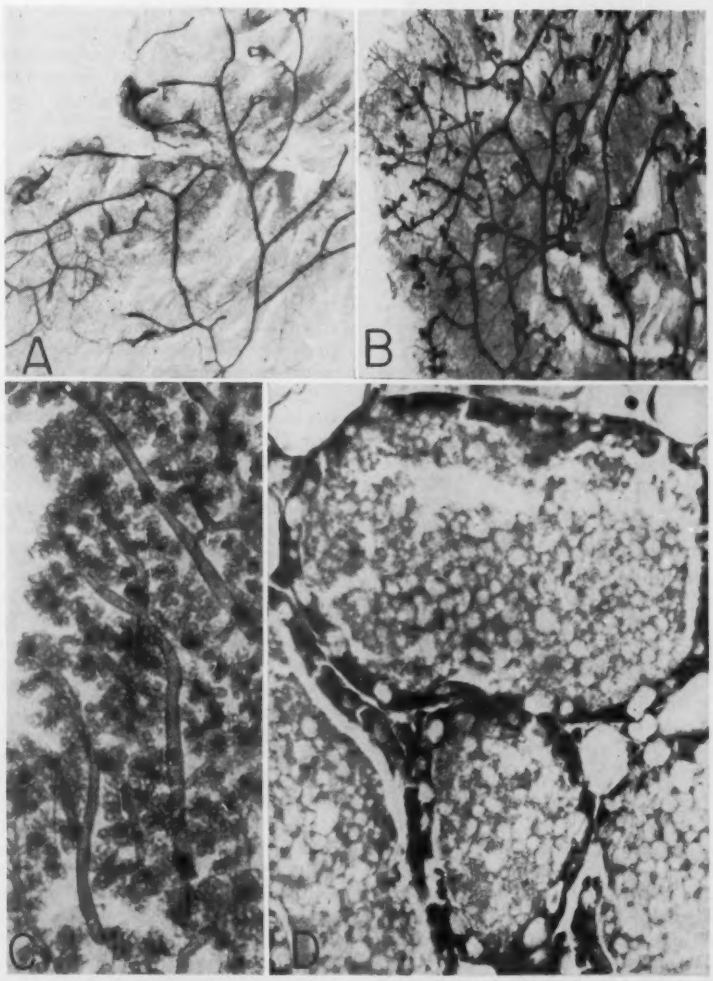

Fig. 1 (*A*) Mammary gland whole-mount from 3½-month-old female, 15 days after removal of pituitary, ovaries, and adrenals. Hematoxylin. (×7). (*B*) Mammary gland whole-mount from triply operated female treated for 20 days with estradiol, deoxycorticosterone acetate, and somatotropin. Hematoxylin. (×7). (*C*) Mammary gland whole-mount from triply operated female treated with estradiol, progesterone, and somatotropin daily for 15 days, followed by cortisol acetate and somatotropin daily for 5 days. Hematoxylin. (×15). (*D*) Section through a part of the mammary gland seen in *C*. Masson. (×400).

postoperatively. Hence, the observed effects of somatotropin are not the result of synergism with pituitary hormones that might remain in the blood for a short time after hypophysectomy.

Our observations indicate that somatotropin can synergize with appropriate ovarian or adrenocortical steroids, or both, to induce ductal development, lobulo-alveolar development, and lactogenesis in the mammary glands of triply operated C3H/He CRGL female mice. Unlike the rat (*1*), our C3H mouse is responsive to the mammogenic and lactogenic actions of somatotropin even in the absence of appreciable amounts of mammotropin (*6*).

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11 April 1958

Intrasubject Conditioning as a Function of the Intensity of the Unconditioned Stimulus

Abstract. Subjects conditioned concurrently to two different conditioned stimuli, light and tone, exhibited a significantly higher level of conditioning to the stimulus paired with a strong unconditioned stimulus than to the stimulus paired with a weak one. The findings suggest that habit strength in aversive conditioning varies with the intensity of the unconditioned stimulus.

In a number of experiments (*1*) concerned with the problem of whether habit strength (H) is a function of the intensity of the unconditioned stimulus (UCS), the conditioning performances of two different groups of subjects (S's), equated for level of drive (D) but differing with respect to reinforcement conditions, were compared. The finding of a higher level of performance on the part of S's that received a strong UCS on trials producing conditioning (that is, habit growth) as compared with S's who were given a weak UCS on such trials was interpreted to mean that habit strength (H) varies with the level of intensity (noxiousness) of the UCS.

In the present experiment (*2*) we attempted to obtain further evidence on this problem by comparing the conditioning performances of a single group of S's under two different reinforcement intensities. All S's were conditioned concurrently to two different conditioned stimuli (CS's) (light and tone). Half of the S's had the light paired with a strong UCS and the tone paired with a weak UCS. In the case of the other half of the S's these relations were reversed, the tone being paired with the strong UCS and the light with the weak UCS. Our primary interest lay in a comparison of the level of conditioning performance to the CS paired with the strong UCS with that to the CS paired with the weak UCS. On the basis of the findings of the previous experiments and the interpretation offered by them, namely, that a greater amount of H is established to a CS paired with a strong UCS than to one paired with a weak UCS, it may be predicted that a higher level of conditioning performance will be made to the CS paired with the stronger UCS.

Twenty-four men and 24 women from an introductory course in psychology served as S's in this experiment. Nine other S's were eliminated, including three who met the criterion defining a voluntary responder (*3*), two who gave conditioned responses (CR's) to initial test trial presentations of the CS, and four who adapted to the air puff. An S was considered to have adapted to the puff if the mean amplitude of the unconditioned responses (UCR's) made on the last 10 trials involving the weak puff was less than 50 percent of that on the first 10 weak puff trials.

The apparatus was the same as that used in earlier studies (*1*) except for the addition of a 1000-cycle tone CS produced by a loudspeaker driven by a Hewlett-Packard oscillator.

Instructions and preliminary trials were similar to those of the previous studies. A variable (15, 20, 25 sec) intertrial interval was used, as well as a ready signal which preceded the onset of the CS by 2, 3, or 4 seconds.

Each S received 100 conditioning trials, 50 of which involved a tone CS and 50 a light CS. The two CS's were given in a prearranged sequence within which neither of the CS's occurred more than twice in succession. For half of the S's the tone was always paired with a strong (2 lb/in.^{2}) puff and the light with a weak (0.33 lb/in.^{2}) puff, while the other half received the reverse pairing, a 0.33 lb/in.^{2} puff with the light and a 2 lb/in.^{2} puff with the tone. The CS-UCS interval was 500 msec, with the duration of the CS 550 msec and the duration of the UCS 50 msec. At the end of the experiment all S's were questioned regarding their understanding of the purpose of the experiment and cautioned not to discuss the experiment with other members of the class.

Table 1. Summary of analysis of variance of frequency of CR's for trials 1 to 20 and 61 to 80.

Source	*df*	*MS*	*F*	*P*
Between S's	47			
A B (b)	1			
Error (b)	46	14.94		
Within S's	144			
CS (A)	1	40.33	11.86	.005
Puff (B)	1	44.08	12.96	.001
Trials (C)	1	752.08	191.37	.001
A C	1	3.01	1.11	> .200
B C	1	18.76	6.90	.025
A B (b) C	1	1.34	< 1.00	
Error W	138	3.35		
$Error_1$ W	46	3.40		
$Error_2$ W	46	3.93		
$Error_3$ W	46	2.72		
Total	191			

Acquisition curves in terms of the number of anticipatory CR's given to the CS paired with the strong UCS and to the CS paired with the weak UCS are shown in Fig. 1. As may be observed, the curve for the strong puff is consistently above the curve for the weak puff, with the difference gradually increasing during the course of conditioning. A summary of an analysis of variance, involving three within-subjects factors and one between-subjects interaction (*4*, p. 279, Type VII), based upon the first and last blocks of ten conditioning trials is presented in Table 1. As may be seen from the lower portion of this table, the differential effect of the UCS variable was highly significant, the obtained F providing a P value of .001. Also of interest is the fact that the interaction between the UCS variable and blocks of conditioning trials was significant (P = .025), thus indicating that the diver-

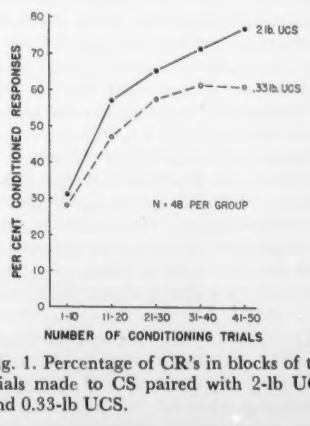

Fig. 1. Percentage of CR's in blocks of ten trials made to CS paired with 2-lb UCS and 0.33-lb UCS.

gence of the conditioning curves was not a chance one.

Further examination of Table 1 reveals that the CS variable—that is, whether tone or light—also significantly affected the level of conditioning performance. Indeed, this variable gave a slightly larger value of F than did the UCS variable. It will be observed, however, that the interaction term between CS and trial blocks was not significant. This implies that the acquisition curves for the tone and light did not diverge. Presumably the different performance in the case of the two CS's reflects Hull's stimulus dynamism variable, V.

The results of this experiment add still further evidence supporting the interpretation that habit strength (H) is a function of the intensity of the UCS. In the previous experiments (*1*) the performance of two independent groups of S's whose drive level (D) was equated by employing two different puff intensities equally often was compared. It was found in every instance that the group which had the CS paired with the strong UCS exhibited a higher level of conditioning performance than did the group which had the CS paired with the weak UCS. The present experiment involves a comparison of the levels of conditioning to two different CS's, light and tone, established concurrently in the same group of S's. Controlling for any possible effects of the two CS's per se, the analysis of the data of this experiment clearly shows that a higher level of response was given when the CS was paired with the strong UCS than in the case in which the CS was paired with the weak UCS. Since the two conditionings were within the same S, the level of D must have been the same and thus equal for the two CR's. This performance difference reflects, then, a greater development of H in the case of the conditioned reflex established with the stronger UCS.

As the number of conditioning trials in our several experiments concerned with this problem was not sufficient to reach the performance asymptote, one cannot infer for certain whether it is the maximum to which H grows that is related to intensity of the UCS, or whether it is the parameter determining the rate of approach of H to its asymptote. Examination of the curves from the several experiments, including Fig. 1 of the present study, suggests that it is the asymptote of H which is affected and not the rate-of-approach parameter.

In concluding, we should like to call attention once again to the fact that, while the findings of these studies may be interpreted as supporting the drive-reduction versions of reinforcement theory (*5*), we prefer to confine our interpretation to the more general conception that habit formation in such aversive types of conditioning is some function of the intensity of the UCS. Evidence with regard to the precise nature of the reinforcing mechanism in such learning requires other, presumably physiological, types of experimentation.

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6 June 1958

Luminosity Curves of Normal and Dichromatic Observers

The question of the relative heights of the luminosity curves of normal and color-blind observers is an important one for theories of color vision, but one which has received very little investigation. If color blindness is due to the absence or inactivation of one or more of the normal retinal receptor-types, a color-blind observer should demonstrate a loss of luminosity in the spectral region to which the missing receptors would normally respond. If the missing receptors were replaced by receptors of a different type, it might be expected that a corresponding enhancement of luminosity would be demonstrable in the spectral region to which this type of receptor was responsive. Alterations in photopigment content of visual cells, substitutions or alterations in the photochemicals themselves, or abnormal retinal distributions of the receptor-types or their neural connections would similarly be expected to produce corresponding luminosity losses and gains. Thus, comparative studies of the luminosity curves of color-defective observers should provide some of the facts necessary, but not yet available, for evaluation of the various theories of color blindness.

Unfortunately, conventionally determined relative luminosity curves provide no basis for direct interobserver comparison of luminosities, since there is no assurance that the standard light to which each test wavelength is matched appeared equally bright to each observer. Abnormalities in the shapes of such curves could be the result of luminosity losses, or gains, or both.

In an attempt to make the desired interobserver comparisons, Hecht and Hsia in 1946 (*1*) determined the relative energy levels of the foveal thresholds of several protanopes, deuteranopes, and normals, for five colors in a 1-deg test field. Plotting relative threshold sensitivities (reciprocals of relative energy) versus wavelength, and measuring the areas under these "luminosity curves," Hecht and Hsia concluded that protanopes lose 49 percent and deuteranopes lose 39 percent of the luminosity of an equal-energy spectrum. Very recently, Hsia and Graham (*2*) repeated these measurements with other subjects. Though their findings differed markedly from those of the earlier study, they nevertheless concluded that there was basic agreement inasmuch as both investigations showed luminosity losses for deuteranopes as well as for protanopes.

One objection to this procedure lies in the fact that the comparisons of observers were made only at the threshold of vision in the dark-adapted eye but were interpreted in terms of photopic luminosities. The stimuli may have been confined to foveal cones [though a 1-deg test spot probably covers about four times the area of the "rod-free" region of the fovea (*3*)], but even this does not permit the inference that photopic brightnesses are in the same relation to each other as are foveal thresholds, either when different wavelengths are compared for a single observer or when different observers are compared at a single wavelength. To afford a basis for photopic comparisons, the use of a photopic visual function would be preferable to the threshold of cone vision as the criterion of equality of brightness. The criterion employed in the present study was equality of the critical frequency of flicker-fusion (CFF) (*4*).

Nine normals, six deuteranopes, and five protanopes served as subjects. The flicker apparatus presented a 5-deg test field (*5*) in Maxwellian view to the subject, who was positioned by means of a mouthbite containing his dental impression. Fourteen narrow spectral regions were isolated as test lights by means of interference filters combined with gelatin filters. Luminance of the test field was varied by neutral filters and a neutral wedge. For these experiments four frequencies of intermittence of the test light were used: 20, 25, 30, and 40 flashes per second, with a light-dark ratio of 1:1. The subject varied the luminance of the test field until flicker was just eliminated—that is, he set the neutral wedge so that the slightest in-

crease in field luminance would result in the appearance of flicker. Each observer made five successive settings at each frequency for the 14 wavelengths tested.

From the calibration data for the instrument, the average wedge settings were translated into relative energies. The reciprocal of the energy requirement for the normal observers at 555 mμ was taken as 100 percent and all other findings were computed as relative luminosities with reference to this one. The results are shown in Fig. 1, together with the CIE luminosity curve for the 1931 standard observer.

A striking feature of these curves is the unusual shape of each, with a sharp notch at 570 mμ and a hump at 590 mμ. The marked lack of similarity to the CIE curve is not unexpected, however, for irregularities of this general nature have been reported by many recent investigators, though the sizes and spectral locations of the variously reported humps and notches have varied considerably.

The results show that at four photopic levels CFF (and, hence, absolute luminosities) of lights of wavelengths shorter than about 520 mμ are substantially equal for protanopes, deuteranopes, and normals. For longer wavelengths protanopes show a loss in brightness, which agrees with the usual explanation of protanopia as a loss system in which the red receptors are absent or nonfunctional. Deuteranopes, on the other hand, show supernormal brightness at these longer wavelengths. The areas under the protanope curves average only 64.7 percent of the areas under the normal curves, indicating a luminosity loss in an equal-energy spectrum of 35.3 percent, while the deuteranopes show an average luminosity gain of 36.2 percent.

The theoretical implications of these findings are numerous and cannot be discussed here. Clearly, however, the finding of deuteranopic brightness *enhancement* (and in the spectral region where protanopes have brightness reduction) constitutes a strong argument against any theory of a "loss" basis for deuteranopia and will necessitate careful reexamination of other existing theories of color vision and color blindness.

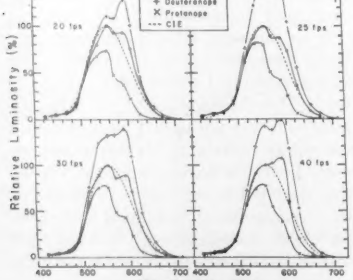

Fig. 1. Luminosity curves of normal and dichromatic observers, showing relative heights at each of four photopic levels. Plotted points represent reciprocals of relative energies required for flicker-fusion at the frequencies indicated. The luminosity curve of the CIE standard observer is included for comparison.

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4. The use of CFF in this way is not to be confused with flicker photometry, an entirely different procedure which utilizes a "standard" light and, hence, is useless for the type of inter-observer comparisons desired here.
5. A 5-deg field was used to minimize individual variations resulting from intramacular structural inhomogeneities (see *3*). Since photopic test luminances were used, it was not necessary to attempt to isolate cone function by means of a small field.

5 May 1958

Biosynthesis of Radioactive Mannitol from $C^{14}O_2$ by Fucus vesiculosus

It has recently been shown that *Fucus vesiculosus* plants produce large amounts of radioactive mannitol during photosynthesis in $C^{14}O_2$ (*1*, *2*). Under favorable conditions as much as 95 percent of the radioactivity in alcohol-soluble compounds, or 65 percent of the total radioactivity in the plant, was found in mannitol. This observation suggested a possible method for the laboratory-scale production of radioactive mannitol to be used for subsequent metabolic studies (*3*).

It was found in earlier experiments that the most rapid synthesis of radioactive mannitol in *F. vesiculosus* took place when the plants were suspended in sea water through which air containing 10 percent CO_2 was bubbled (*2*). In the present experiment *F. vesiculosus* plants were collected on a sunny morning in October. A sample consisting of 40 g of sterile fronds cut into 6-inch lengths was immediately prepared and suspended in 700 ml of fresh sea water in the light chamber of a photosynthesis apparatus. A detailed description of this apparatus is given elsewhere (*1*). One gram of $C^{14}O_2$ with a total activity of 5 mc was released in the photosynthesis apparatus to give a gas mixture of 10 percent CO_2 in air. This gas mixture was continuously bubbled through the sea water, and its C^{14} content was automatically monitored and recorded. The plants were held at 16°C and illuminated by water-screened incandescent lamps giving 1600 ft-ca.

After 23 hours of photosynthesis 90 percent of the C^{14} offered had been taken up, and since the rate of photosynthesis had decreased considerably the experiment was stopped. The plants were rinsed quickly in distilled water and extracted thrice with hot 60 percent ethanol. The extracts were evaporated to a small volume in a vacuum and streaked to the short edges of two sheets of Whatman seed-test paper. These were run downwards with sewn-on wicks and stirrups (*4*) in phenol:water (21:8) for 5 days, when the solvent front reached the bottom of the sheets. The strongly radioactive mannitol-containing bands were located by autoradiography and cut out. They were twice eluted with water, and the combined eluates were concentrated to dryness in a vacuum. The crude material so obtained was extracted with 400 ml of boiling *n*-butanol, from which mannitol crystallized on cooling to room temperature. The product was washed with 95 percent ethanol and absolute ethanol followed by ether, and was then dried in a vacuum oven at 50°C.

The yield was 700 mg of mannitol with specific activity of 0.82 mc per millimole. The recovery of supplied C^{14} as mannitol was 63 percent. The isolated mannitol was tested chromatographically in butanol: acetic acid:water, butanol: ethanol:water, phenol:water, and pyridine:ethyl acetate:water solvents and was found to contain no detectable sugar, amino acid, or radioactive impurities. The sensitivity of these tests was sufficient to reveal 0.2 percent of such impurities. Nonradioactive mannitol prepared from *F. vesiculosus* in an identical manner, but using $C^{12}O_2$, was tested for specific rotation and melting point with the results: melting point (Kofler melting point apparatus, corrected), 163° to 164°C; authentic mannitol, 165° to 166°C; mixed melting point with authentic mannitol, 163° to 165°C; $[\alpha]_D^{26}$, +28.4° (c = 1.03, in borax); published value, +28.3°.

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25 April 1958

Concept Formation in Chimpanzees

Abstract. Animals performed with a high degree of accuracy on two concept problems. The bases of these performances, however, differed qualitatively. In one problem, successful performance was based upon responding to specific stimulus patterns. In the other problem, successful performance was based upon responding to the common element or concept.

Learning to respond to a class of stimuli on the basis of some common physical characteristic is referred to as "concept formation." Although concept formation has been demonstrated in animals (*1*), the experimental analysis of this complex behavioral process has received little attention in recent years. This report presents some results obtained with a new technique for the study of concept formation (*2*).

The two subjects were food-deprived chimpanzees. These animals had been trained to press a telephone key for food reward (reinforcement). Above the telephone key there were nine small Plexiglas windows arrayed in a 3-by-3 square. Stimulus patterns were programmed by illuminating some Plexiglas windows while leaving others dark. A sequence of 26 successive stimulus patterns, 13 positive and 13 negative, could be programmed (*3*). The positive stimulus patterns were characterized by a common element which was not present in any of the negative patterns.

During the presentation of positive stimulus patterns, a 100-response variable-ratio schedule of reinforcement was in effect—that is, the number of times that the subject had to press the key for food varied randomly from 1 to 200, with a mean of 100 (*4*). Positive stimulus patterns terminated at reinforcement. During the presentation of negative stimulus patterns, extinction was in effect —that is, responses were not reinforced. Negative stimulus patterns terminated when the animal had not pressed the telephone key for 1 minute. Experimental sessions were interrupted for a 30-second "time-out" period after the termination of each stimulus pattern and ended when 50 reinforcements had been delivered (*4*). The experimental procedures were automatically programmed, and the results were automatically recorded.

Two concept problems were investigated. Initially, on each of these problems, the animals were repeatedly exposed to one sequence of stimulus patterns. When the animals' behavior showed no consistent trend, the stimulus patterns were presented in a new sequence, but none of the specific stimulus patterns was changed. After several experimental sessions on the new sequence, 6 positive and 6 negative stimulus patterns were changed. However, the concept was not changed.

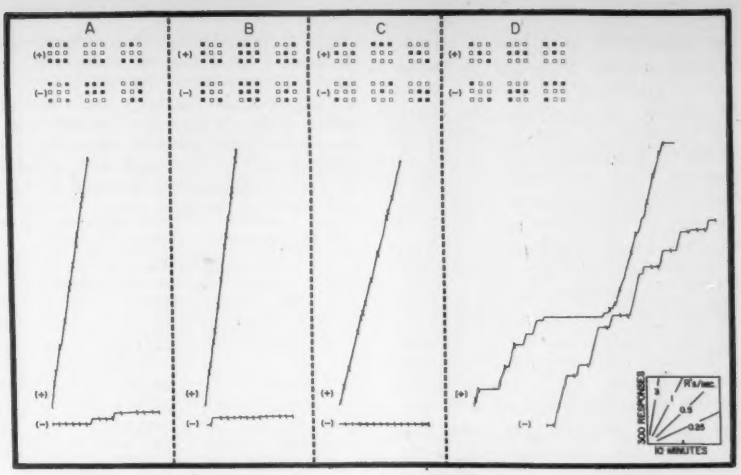

Fig. 1. Representative stimulus patterns and cumulative response curves, showing the effects of changing specific stimulus patterns without changing the concept. Sections *A* and *B* are from the first concept problem; sections *C* and *D* are from the second concept problem.

Representative positive and negative stimulus patterns from each of four sequences are shown in the upper sections of Fig. 1. The dark squares correspond to illuminated windows. Cumulative response records from each of the four sequences are shown in the lower sections of Fig. 1. Responses during positive and negative stimulus patterns were recorded separately, and they are presented in the upper and lower curves, respectively. The short diagonal strokes on these curves indicate the points at which stimulus presentations terminated. The records did not run during the 30-second intervals between stimulus presentations. Coordinates and representative slopes are presented in the lower right corner of the figure.

The stimulus patterns in the upper section of Fig. 1*A* exemplify the first concept problem. The illumination of the bottom row of windows was the concept. The cumulative response records in the lower section of Fig. 1*A* show the performance that had developed after about 100 experimental hours on the first sequence of stimulus patterns. The animals responded at high rates during positive stimulus patterns, but they seldom responded during the negative stimulus patterns. When the stimulus patterns were presented in a new sequence, there was no disruption of this performance. When 6 positive and 6 negative stimulus patterns were changed without changing the concept, there was still no disruption of the performance. For example, the stimulus patterns shown in Fig. 1*A* were changed to those shown in Fig. 1*B*. Cumulative records from the first sequence following the change are shown in the lower section of Fig. 1*B*.

The stimulus patterns in the upper section of Fig. 1*C* exemplify the second concept problem. The illumination of three windows was the common element in positive stimulus patterns; two or four windows were illuminated in negative stimulus patterns. The cumulative response records in the lower section of Fig. 1*C* show the performance that had developed after about 150 experimental hours on this sequence. As in the first concept problem, this performance was not disrupted when the stimulus patterns were presented in a new sequence. However, when 6 positive and 6 negative stimulus patterns were changed without changing the concept, performance was markedly disrupted. The changed stimulus patterns are exemplified in the upper section of Fig. 1*D*; cumulative response records from the first sequence following this change are shown in the lower section of Fig. 1*D*. There was excessive initial pausing in two of the positive patterns, and high rates of responding prevailed in the negative patterns that had been changed.

The animals developed clear discriminations on both concept problems. Neither discrimination was affected by changing the sequence in which the stimulus patterns were presented. However, the discriminations were differentially affected by changing specific stimulus patterns without changing the concept. Thus, the discriminations were qualitatively different. In the first concept problem, the discrimination was based upon response to the common element. In the second concept problem, the discrimination was based upon response to specific stimulus patterns—that is, the chimpanzees were respond-

ing appropriately to at least 12 specific stimulus patterns presented in successive fashion. In further studies, it would be possible to determine the maximum number of specific patterns to which these animals could respond effectively. Until such studies have been completed, investigations of complex discriminations with chimpanzees should be interpreted with caution, until the bases of the discriminations have been assessed.

With the procedure described above, concept formation was a function of the concept problem. The common element of the first concept problem (the bottom row of windows) had a specific spatial location; the common element of the second concept problem (any three windows) did not. This difference in the level of abstractness of the two problems may have been an important factor. With a different procedure, the chimpanzees could probably have been trained to respond to the common element of the second concept problem. If the stimulus patterns were changed after each sequence without changing the concept, for example, the animals would have been unable to maintain a discrimination by responding to specific patterns.

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11 June 1958

Interpretation of Properdin Levels Determined by Phage Neutralization Technique

It has been demonstrated by Van Vunakis, Barlow, and Levine (*1, 2*) that the properdin system neutralizes the *Escherichia coli* phage T2r$^+$ (*3*). These authors have described a precise and reproducible procedure for determining the phage neutralizing (PhN) activity of human serum and have suggested that it affords a means of measuring properdin levels (*4*). In brief, the technique measures phage neutralizing activity in terms of the amount of serum (PhN_{50}) required to neutralize 50 percent of the phage introduced into the system under the experimental conditions used. During the course of an investigation of the influence of complement (C′) on the neutralization of bacteriophage by immune antibody, some observations have been made that indicate the necessity for caution in interpreting properdin titers determined by the phage procedure. In addition, these findings suggest that concepts concerning the nature of the properdin system should be carefully reconsidered.

Table 1. Neutralization titers of human sera tested with T2, T6, and T7 bacteriophage. Diluent: 0.126*M* Veronal buffer, *p*H 7.4 to 7.6, containing 0.1 percent 5X crystalline bovine serum albumin (Armour & Co.), Ca^{++} (0.00015*M*), and Mg^{++} (0.0005*M*). Procedure: Reaction mixture tubes, sitting in an ice bath, were prepared, diluent (to give a final volume of 1.5 ml), serum dilutions, and phage (0.5 ml containing 7.5×10^4 infectious units) being added in that order. The tubes were well mixed and incubated for 90 minutes at 37°C. They were then chilled, diluted, and titrated for residual phage. PhN_{50} titers were calculated as described by Barlow *et al.* (*4*).

Serum	PhN_{50}/ml and indicator phages*			Hemolytic titer ($C'H_{50}$/ml)
	T2	T6	T7	
NH	20	24	19	24
B	15	20	28	Not done
KC	12(12)	28(24)	42(40)	31
G	25(22)	19(16)	7(8)	31
DM	24(24)	24(21)	56(43)	30
SB	16(14)	27(27)	4(3)	32
AC	9(8)	26(25)	13(10)	28
DB	15	31	35	41

* Figures in parenthesis are serum titers determined 3 to 4 months after the initial assay. Sera were stored at −35°C.

Several different phages of the T series (T2, T6, and T7) were to be used in this study, but the presence of normally occurring neutralizing substance (properdin) in the guinea pig serum being used as a C′ source presented an obvious complication. As was indicated by Barlow *et al.* (*2*), repeated absorptions of the serum with zymosan resulted in a C′ reagent essentially devoid of phage neutralizing activity. The present report stems from the observation that, prior to absorption with zymosan, this serum neutralized these three phages to varying degrees. It was wondered whether this variation could be attributed to a difference in susceptibility of the phages, or whether it perhaps indicated that this serum contained varying amounts of neutralizing substances directed against the different phage types. It was felt that these questions could possibly be answered by assaying several sera and by using all three phage types. If the differences observed were due to varying susceptibility of the phages to a single neutralizing substance, one would expect the ratio of serum titers obtained with the three different phages to remain approximately constant from one serum to another. On the other hand, the failure to obtain such a correlation would suggest that the neutralizing substance(s) had some degree of specificity and could be present in different sera in varying amounts.

Several human sera showing normal hemolytic C′ levels were assayed for activity against T2, T6, and T7 phages by a procedure similar to that described by Barlow, Van Vunakis, and Levine (*4, 5*). Heated serum samples were included in all cases, and no significant neutralization was found. As is shown in Table 1, no constant ratio occurs—that is, the phage neutralizing activity of a serum against one of the phage types does not necessarily correlate with its activity toward the other two. It is clear that if one were to use the neutralization of T6 or T7 as an indicator of serum properdin levels, one might obtain a distinctly different impression than he would if T2 were used. It is obvious that circumspect judgment is necessary in the evaluation of properdin levels determined by this procedure, and indeed, the question of the true nature of properdin is raised.

These findings not only raise the question of the significance of properdin levels determined by the phage technique but also indicate that properdin may have some degree of specificity which is suggestive of antibody. Nelson (*6*) has presented evidence and a hypothesis suggesting that the properdin system may be explained in terms of normally occurring antibody operating in conjunction with C′ without introducing the concept of the new entity, properdin. Skarnes and Watson (*7*) have indicated that properdin and normal antibody may be the same substance in view of the numerous properties shared by them.

From the data given in the present report, and also from the failure of others to find a satisfactory correlation between properdin titers determined by the zymosan assay method (*8*) with those determined by the phage tech-

nique (*4*) or the tanned erythrocyte procedure (*9*), it is suggested that these discrepancies may be attributable to the fact that different substances are being measured by the different indicator systems. Thus, one is drawn to the conclusion that either there are several different properdins, or that properdin is a family of cross-reacting antibodies capable of combining with zymosan. The inability to correlate properdin levels determined by the various procedures might then be due to the fact that antigens such as tanned erythrocytes, T2, T6, and T7 phage are measuring a specific portion of the properdin or normal antibody pool which may vary both in quantity and quality from serum to serum.

Before the conclusion is drawn that properdin is normal antibody, however, one distinguishing feature of the properdin system should be stressed. This is the demonstration by Pillemer *et al.* (*10*) that C′ is required not only for the manifestation of the viricidal, bactericidal, and hemolytic reactions attributed to the properdin system but also for the combination of properdin with zymosan and other polysaccharides reactive in the system. While C′ may be essential for bactericidal and hemolytic reactions by immune antibody, it is clear that it is not required for the formation of antigen-antibody complexes. Thus, if properdin is to be considered normal antibody, it will be necessary to revise our concepts concerning the nature of normal antibody-antigen reactions in order to incorporate C′ as an essential cofactor. While it may be premature to postulate a role for C′ in such reactions, the multivalent or cross-linking concept of C′ as presented by Weigle and Maurer (*11*) might be considered with respect to this problem. It is possible to envisage C′ as a stabilizer of readily dissociable immune complexes by virtue of its cross-linking activity. Thus, it might both play a role in the formation of certain low-avidity antibody-antigen complexes and serve as an essential component for the manifestation of such unions where bactericidal or hemolytic reactions are involved. It is hoped that experiments being undertaken may shed further light on the role of C′ in properdin or normal antibody reactions, or both (*12*).

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8 April 1958

Infection of Human Volunteers with Type 2 Hemadsorption Virus

The hemadsorption viruses, types 1 and 2, are new members of the myxovirus group which have recently been recovered from infants and children with respiratory illness (*1*). Subsequent studies have provided evidence that a considerable proportion of respiratory illness in children during the winter of 1957–1958 was associated with the hemadsorption viruses (*2*). A study to determine whether type 2 virus could produce infection and illness in adults was performed with male volunteers (*3*). Although placebo controls were not employed in this pilot study, valuable information was acquired because illness was correlated with the occurrence of infection.

The virus used for the inoculum was derived from an infant with acute laryngotracheobronchitis. The original throat swab specimen from this infant was inoculated into a monkey kidney tissue-culture flask maintained with Eagle's basal medium without serum. After 7 days' incubation at 36°C the tissue culture fluid was filtered through a Selas 0.03 filter and stored at −50°C. Safety tests were carried out in monkey kidney and HeLa cultures and in suckling and adult mice, guinea pigs, rabbits, and various bacteriologic media. No bacteria or contaminating viruses were detected.

Thirty-two healthy male volunteers, ranging in age from 21 to 46 years (mean, 28 years) were selected from among the inmates at the Patuxent Institution at Jessup, Md. Seven of the men did not have neutralizing antibody for type 2 virus. The remaining 25 volunteers had antibody levels of 1:4 to 1:128 (mean of 1:21). The volunteers were isolated in separate cells and had an independent medical examination each day by two physicians. The laboratory techniques for virus isolation, virus identification, and serologic testing by hemagglutination-inhibition, complement-fixation, and neutralization have been described (*1*).

Each volunteer was given a total of 1 ml of undiluted tissue culture fluid by swabbing the posterior oropharynx and the lower palpebral conjunctivae and by spraying and instillation into the nose and oropharynx. Each volunteer received 80 TCD_{50} as determined by a simultaneous titration.

Throat swabs taken from all the volunteers on the 2nd, 3rd, 6th, and 7th days were tested simultaneously for virus in monkey kidney tissue culture by the hemadsorption technique (*4*). Type 2 virus was recovered from 24 of the men. Virus was not detectable on the 2nd day after inoculation but was isolated from 10 of the volunteers on the 3rd day. Twenty-two were positive on the 6th day, with 12 of the isolations coming from individuals with a negative test on the 3rd day. Nineteen volunteers had virus on the 7th day, with two of these individuals shedding virus for the first time.

A total of 25 men developed a rise in antibody for type 2 virus. Each of the volunteers from whom virus was recovered had a serologic response. Twenty-two men developed a rise in neutralizing antibody, 18 in hemagglutination-inhibition antibody, and 14 in complement-fixing antibody. The one individual with a positive serologic response from whom virus was not recovered developed antibody demonstrable by neutralization, hemagglutination-inhibition, and complement-fixation. None of the volunteers developed a rise in complement-fixing antibody for adenovirus or Asian influenza.

When clinical illness failed to develop by the 5th day, the men were released from isolation. On the 6th day, however, six of the men reported to the infirmary complaining of respiratory illness and immediately all volunteers were returned to isolation. Examination of the other volunteers revealed that additional individuals had onsets of respiratory illness on this day. The onset of these illnesses coincided with the time when the greatest number of volunteers had virus demonstrable in their upper respiratory tracts. For the most part the illness was mild with prompt and uneventful recov-

ery occurring within 2 to 3 days. The volunteers were released from isolation on the 11th day.

The most common symptoms of this "cold-like" illness were nasal obstruction and discharge, coughing, and sneezing. Less frequent were sore throat, headache, ocular complaints, vague chest pain after coughing, and chilliness. Aches, vomiting, anorexia, and hoarseness were present in an occasional individual. Physical examination revealed a reddened edematous pharynx at the onset of clinical symptoms. A rhinorrhea that was serous and later mucoid, and inflamed nasal mucosa and tonsils, were the next most common findings. Four individuals had lacrimation and a mild conjunctivitis. Lung fields were clear by auscultation, percussion, and x-ray. Four men, one of whom showed no evidence of infection, had a low-grade fever (100 to 101°F). White blood counts were within normal limits.

Eighteen of the volunteers developed clinical illness. In this group, 17 were shown by laboratory tests to have been infected with type 2 virus; this agent was isolated from 16 of the men, and the remaining volunteer developed an antibody rise. In the group of 14 who did not become ill, only eight were infected with type 2 virus. A significant correlation between clinical illness and infection is suggested by the data (P equals 0.035 by the chi-square test with Yates correction for small numbers). The physicians who examined the volunteers were in good accord about what constituted clinical illness.

Eight days after the premature release of the volunteers from isolation a small outbreak of respiratory illness occurred in the general prison population. Eighteen individuals who were not in the study became ill with a mild "cold-like" illness without fever that lasted 2 to 3 days. Type 2 virus was recovered from eight of the individuals in this group.

The results of this study suggest that type 2 virus can cause respiratory illness in adults. This conclusion is consistent with the findings of previous epidemiologic investigations which indicated an association of this virus with minor as well as severe respiratory illness in small children (*2*).

It is of interest that of the 25 men who were infected with as small a quantity of virus as 80 TCD_{50}, 18 had neutralizing antibody levels of 1:4 to 1:64 (mean of 1:13) prior to challenge. Previous antigenic experience either with type 2 virus or a related agent may be one of the factors responsible for the mildness of the observed illness. The prolonged incubation period seen with type 2 virus is not unlike that observed with a nasal secretion (NS 111) employed by Jackson *et al.* in their volunteer studies (*5*). In the present study the apparent long incubation interval could reflect either a property of the virus or the small size of the challenge inoculum.

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21 May 1958

Induction of Tolerance of Skin Isografts from Male Donors in Female Mice

In certain inbred strains of mice, Eichwald and Silmser (*1*) and subsequently other workers (*2*) have observed that whereas skin *isografts*—that is, grafts transplanted between members of the same inbred strain—are permanently accepted when transplanted between animals of the same sex or from females to males, females usually reject grafts from male donors after an initial period of well-being of highly variable duration. Similar results have been obtained with isografts of thymic and of lymph node tissue (*3*).

Table 1. Fate of skin isografts transplanted to mice of the C57BL/6 strain.

Sex		No. grafted	Distribution of survival times of grafts (days)		
Donor	Recipient		< 30	> 30 < 60	> 60
M	M	16			16
F	F	23			23
F	M	29			29
M	F	29	9	16	4*
M	F†	20			20

* Breakdown of three of these grafts was complete by 100 days.
† Injected at birth with male spleen cells.

The most obvious and acceptable explanation of this rejection of tissues of male origin by the females is that originally postulated by Eichwald and Silmser (*1*). Like the destruction of skin *homografts* transplanted between mice of *different* strains, it is the result of an immunological response or sensitization on the part of the host against a "foreign" transplantation antigen (or antigens) in the graft, determined, in the present instance, by a histocompatibility gene (or genes) located on the Y chromosome and therefore not present in females. The strongest evidence in support of this immunogenetic interpretation is the fact that a female which has already rejected a male graft will reject a subsequent graft from a male donor much more rapidly (*1*)—that is, there is a "second-stage phenomenon" (*4*), as with skin homografts. Attempts to discover an endocrinological factor in the rejection of these male isografts have so far been unsuccessful (*5*).

In an attempt to obtain further evidence that the rejection of male tissues by females is a straightforward transplantation immunity phenomenon, we have attempted to induce a state of immunological tolerance (*6*) in female mice with respect to the putatively antigenic tissues from male donors. For this work mice of the C57BL/6 strain were employed, since the females were known to reject male grafts with almost complete uniformity and more rapidly than females of the other strains so far investigated. In our control series (Table 1), 28 of 29 females rejected grafts from male donors within 100 days, the median survival time of these grafts, with its confidence limits, being 33.8 (28 to 41 days).

Forty-seven newborn mice, belonging to seven litters, were each injected intravenously with a suspension containing 5 to 10 million living spleen cells prepared from adult male donors. When the animals had grown up, each of the 20 females present was challenged with a graft of isologous skin from a male donor. These grafts have now been under careful observation for 60 days. The fact that all of them are still in perfect condition, with excellent hair crops, demonstrates that a very high degree of tolerance must have been conferred upon the females as a consequence of their exposure to the "male" antigen (or antigens) at birth.

Besides giving strong support to the straightforward immunogenetic explanation of the rejection of male isografts by females, the present findings show that the induction of a very high degree of tolerance is possible, even in response to an exceedingly feeble antigen. Attention is also drawn to the fact that an inbred strain in which practically all the

females reject male grafts may be regarded as a ready-made source of "isogenic resistant" (7) animals, and this may have some practical application for immunological studies (8).

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28 May 1958

Effects of Intracerebral Injection of Anticholinesterase Drugs on Behavior in Rats

Krech, Rosenzweig, *et al.* have reported that the level of cholinesterase in localized brain areas correlates with the maze learning behavior of rats (1). Animals that utilized visual cues (visual hypothesis) to run an insoluble maze had a lower average cholinesterase activity in visual and somesthetic areas than those that followed spatial cues (spatial hypothesis). These workers proposed (i) that the cortical cholinesterase level is directly proportional to the rate of cortical acetylcholine metabolism; (ii) that a high level of acetylcholine metabolism implies a readier synaptic transmission of impulses, which is responsible for the more adaptive, probabilistic, spatial hypothesis; and (iii) that a low rate of acetylcholine metabolism results in a more stimulus-bound, visual hypothesis. An indirect test of these propositions was the finding that rats displayed increased visual hypotheses in maze running after intraperitoneal injection of small doses of pentobarbital sodium. This drug inhibits acetylcholine synthesis (2).

In the study reported here (3), attempts were made to test whether the cortical level of acetylcholine influences the maze running behavior of rats. Two anticholinesterase drugs, physostigmine (eserine) and diisopropyl fluorophosphate (DFP), were injected either directly into the visual or somesthetic cortex, or directly into one of the lateral ventricles. Such injections were expected to inhibit cerebral cholinesterase, leading to an increase in cortical acetylcholine. A subsequent shift from visual to spatial hypotheses in rats so treated would support the propositions set forth above.

Thirty-four naive male hooded rats, 3 to 4 months old, were used (4): 13 of the Tryon Maze-Bright strain S1 (spatial hypothesis), 13 of the Tryon Maze-Dull strain S3 (visual hypothesis), and 8 of a crossed strain between these two (S13). The experimental period for each rat ranged from 25 to 115 days. We used a four-unit Y-maze (5), and followed the training method and schedule of reinforcement used by Krech *et al.*

All animals were operated upon under ether anesthesia. Four ⅛-in. holes were made in the skull, bilaterally above the visual and somatic areas, for intracortical injections. Such injections were made, without use of anesthetic, by inserting a 26-gauge needle, 2.5 mm long, through the skin and into the holes. Sometimes 2 percent procaine hydrochloride was put on the scalp before injection. For intraventricular injection, a ventricular tube was implanted unilaterally with stereotaxic apparatus (6). To make such injections, a 27-gauge needle, long enough to reach the lateral ventricle, was inserted through the tube.

After appropriate taming and food deprivation, preliminary training consisted of 6 days in which the rats were given either a random-reward or a progressive-reward schedule. Drug experiments were run with a random-reward schedule. Twelve trials (48 choices) were given each day. There were 2 days of testing with drug injection, 2 days of testing with saline injection, and then 2 days of testing without injection. This sequence was repeated on the same rats up to five times. Seven micrograms of eserine or DFP, in 0.10 ml of saline, were injected into both visual cortical areas or both somatic areas of each animal on each day of intracortical injection. This dosage was found to be just subconvulsive. For intraventricular injection, three different concentrations of eserine were used (2, 4, and 7 μg in 0.05 ml of saline). In control experiments, the appropriate volume of normal saline was used. Since some fluid may back out from the needle track after injection, the actual amount and distribution of drug in the brain was uncertain (7).

No overt behavioral effects were observed in about 30 percent of the drug injections. In the remaining 70 percent of the cases (see Table 1) general behavioral disturbances of various sorts were evident. These ranged from excessive washing, grooming, and chewing to tremor, ataxia, incoordinated walking, and, after intraventricular injection, circling to the side opposite the injection. Finally, grand mal convulsions occurred in 16 cases after drug injection and in six cases after saline injection. The rats usually started to run the maze immediately after injection. When there were severe motor disturbances or convulsions, they remained immovable for periods of from 5 to 15 minutes before running.

The results of maze testing are summarized in Table 1. The number of choices of each rat for each day was calculated, according to the criterion of Krech *et al.*, as visual hypothesis, spatial hypothesis, or no hypothesis (a minimum of 33 out of 48 choices of light or dark was scored as visual hypothesis, of

Table 1. Total number of days on which rats of each strain displayed visual, spatial, or no hypothesis behavior, and general behavioral disturbances under each of the experimental conditions. The number of days of testing of each rat varied from 4 to 30. Every rat of each strain was not run under all the conditions. S, spatial hypothesis; V, visual hypothesis; No, no hypothesis; Beh, general behavioral disturbances; Occ., occipital area; Som., somatic area.

Injection	S_1 (spatial) $N = 13$				S_3 (visual) $N = 13$				S_{13} (mixed) $N = 8$			
	S	V	No	Beh	S	V	No	Beh	S	V	No	Beh
Intracortical												
Eserine, Occ.	7	0	3	5	1	7	4	10	4	2	4	2
Eserine, Som.	7	3	3	10	6	9	5	12	7	0	3	4
DFP, Occ.	6	0	3	6	2	6	1	6	—	—	—	—
DFP, Som.	5	0	2	7	0	7	1	6	—	—	—	—
Saline, Occ.	8	3	3	0	5	9	2	2	7	2	2	0
Saline, Som.	13	0	3	3	4	12	2	1	3	0	3	0
No injection	20	2	2	0	11	27	8	0	3	1	5	0
Intraventricular												
Eserine (2 μg)	7	0	1	1	1	5	2	1	2	4	0	0
Eserine (4 μg)	6	0	2	4	0	8	2	6	2	3	1	2
Eserine (7 μg)	11	3	5	13	2	6	0	5	5	6	4	5
Saline	14	2	4	3	3	15	4	3	4	7	5	1
No injection	25	3	9	0	2	21	6	0	3	12	6	0

left or right as spatial hypothesis). The number of days on which rats of each strain showed any one of the hypotheses was summed under each of the experimental conditions. The results showed no significant differences in hypothesis behavior after drug, or saline, or no injection. There was also no difference in the actual number of choices of the rats. The animals maintained their behavioral pattern whether they were run under drug the *first* time or the *fifth* time, and whether they had had the *random-reward* or *progressive-reward* schedule during the preliminary training. To check the possibility that drug effects might not persist through the entire running period, we used the *t*-test to compare the average scores of the first six trials against the last six trials of each session within each strain of rat under drug injection (only those cases with general behavioral effects were included). The results showed no significant difference. It was striking that the animals, in spite of gross motor difficulties, forced circling, or convulsions between trials, ran the maze according to their usual way. Direct injection of eserine or DFP into the brain of rats affected general behavior in the fashion described, suggesting that such injections had achieved the expected alteration in cortical acetylcholine levels. The fact that such injections did not alter the hypotheses displayed by these animals in running a maze seems to indicate that hypothesis behavior is not dependent on cortical levels of acetylcholine.

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7. To help evaluate the consequences of intracortical injection, 12 albino rats were given ten such injections during 2 weeks. Then methylene blue was so injected, and the animals were killed 5, 15, or 30 min later. The dye was spread to about 2 mm around the site of injection after 5 min, but to the entire forebrain at the end of 15 min, mostly in the subarachnoid space and the lateral ventricles. The brains of some experimental animals were serially sectioned and stained with thionin. There was usually a small cavity through the entire thickness of the cortex at the site of intracortical injection. These cavities were lined with glia cells but not encapsulated with connective tissue. In the case of intraventricular injection, besides the needle tract there was sometimes slight damage to structures around the ventricle.

7 May 1958

Concerning a Pigment Commonly Attributed to the Presence of Leuco-Anthocyanin

When an attempt was made to esterify a certain acidic fraction of the water-soluble part of a leaf extract (for example, *Rhododendron ponticum* L.) with boiling 1 percent methanolic hydrochloric acid, the gradual formation of an intense ruby-red coloration was noted. A similar observation had been made previously by O. Rosenheim (*1*), who assumed that a colorless modification of a pigment present in young leaves and stems of the grape (*Vitis vinifera* L.), for which he proposed the general term *leuco-anthocyanin,* was converted by strong acids into what he regarded to be an anthocyanidin. To establish the distribution of the supposed leuco-anthocyan[id]in in the plant kingdom, this method has been applied to leaves of several hundred species of plants (*2*) and to a large variety of other plant materials (*3*). In the majority of cases, the coloration was attributed to the formation of cyanidin and only exceptionally to delphinidin, though no instances are recorded where the anthocyanidin had in fact been isolated or its characteristic absorption curve shown.

In the course of an investigation into the nature of the acidic constituents of leaves, humic acid was isolated (*4*). On heating with 1 percent methanolic hydrochloric acid a pigment was formed, the optical, chromatographic, and chemical behavior of which was identical with that of the pigment obtained when leaves and other plant materials were treated with strong acids. Furthermore, the optical curve of this pigment differs entirely from that of any known anthocyanidin. It shows two characteristic maxima (Fig. 1) in the visible part of the spectrum, one at 548 mμ, $E = 1.76$, the other at 459 mμ, $E = 1.58$ (1 percent methanolic hydrochloric acid) in contrast to the single maximum (Fig. 2) shown by cyanidin at 537 mμ, $E = 1.83$ (1 percent methanolic hydrochloric acid). Also, unlike any anthocyanidin, this pigment is readily decolorized by an alkaline medium such as sodium hydrogen carbonate.

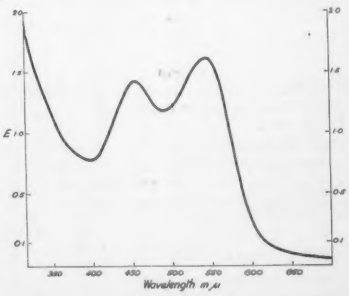

Fig. 1. Optical curve of pigment.

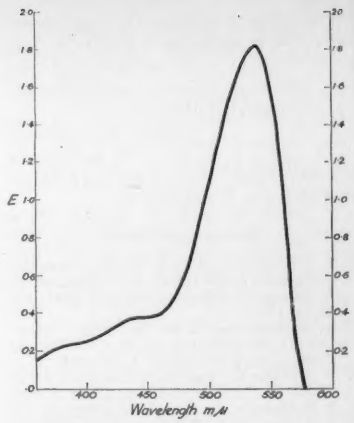

Fig. 2. Optical curve of cyanidin.

So consistent was the formation of this pigment in the case of different plant materials that the color reaction can be considered diagnostic for humic acid, which is almost ubiquitous in the plant kingdom. The chemical and optical properties of the pigment suggest that it is of the trialkyl-methane type and is probably derived from the complicated molecule of humic acid by dehydration and condensation with the aldehyde group present (*5*).

HARRY RAUDNITZ
Department of Forestry, University of Oxford, England

References and Notes

1. O. Rosenheim, *Biochem. J.* **14**, 178 (1920).
2. E. C. Bate-Smith, *ibid.* **58**, 122 (1954); ——— and N. H. Lerner, *ibid.* **58**, 126 (1954); E. C. Bate-Smith and T. Swain, *Chem. and Ind. (London)* **1953**, 377 (1953).
3. For summary of literature, see D. G. Roux, *Nature* **180**, 973 (1957).
4. H. Raudnitz, *Chem. and Ind. (London)* **1957**, 1650 (1957).
5. I am greatly indebted to Dr. F. B. Strauss, Dyson Perrins Laboratory, Oxford, for the optical data, and to Miss M. Lewis for technical assistance. This work has been financed by the Forestry Commission, to which grateful acknowledgment is made.

24 April 1958

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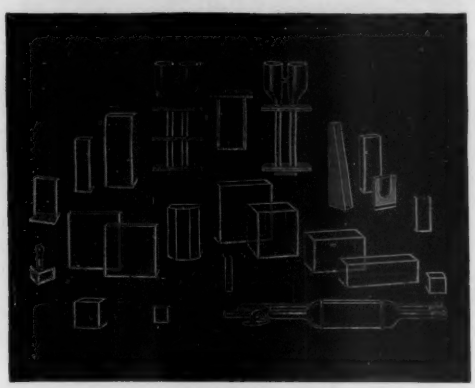

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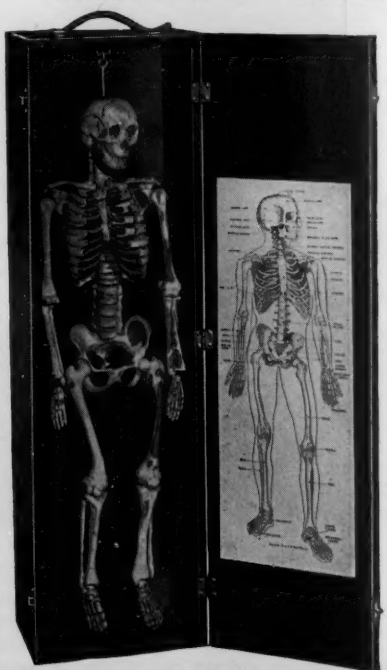

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Meetings

Sedimentology

The fifth International Congress of Sedimentology met in Geneva and Lausanne, Switzerland, 2–7 June, under the presidency of Carl Correns of Göttingen, Germany. Approximately 150 delegates from 19 countries attended, the largest groups coming from France, Switzerland, Holland, Germany, the United States, the Soviet Union, and Italy. Two and a half days were devoted to sessions, the rest to well-planned field trips. Added to the latter were four days of postsession excursions in the Alps between Lake Geneva and Bern. The friendly, informal leadership of Augustin Lombard and Arnold Bersier, hosts respectively at Geneva and Lausanne, added much to the spirit of cordial relations which existed, and there was no sign of past or present international strife. The languages of the session were principally French and English, plus a considerable amount of German.

The principal topic of discussion in lectures and field trips was the origin of the Flysch and Molasse types of sedimentation, which represent respectively the deep trough facies formed in front of the youngest Alps and the overlying alluvial fans formed after the deep basins had been filled. Similar facies have been recognized in many other mountain ranges. One of the most interesting and still unanswered questions is the extent to which turbidity currents supplied sediments to the Flysch; in the discussion on this subject Kuenen of Holland played a leading part. To many of us at the congress, the alternation between the deep-water shales and the breccias or conglomerates seemed to be the most conspicuous feature of the Flysch shown to us. This would appear to indicate the importance of submarine slumping along the sides of the deep trough. Graded bedding, found less commonly, was evidence of occasional turbidity currents.

Sessions devoted to recent sediment studies also aroused interest. Bezrukof of the U.S.S.R. gave some of the results of the recent Russian expeditions in the Pacific. The results included obtaining the longest cores on record (34 meters), the deepest cores (about 10,000 meters in the Kuril trench), and the greatest sounding depths (10,990 meters in the Mariana trench). As in many other deep-water samples, an alternation between fine clays and coarse sediments was found.

Other papers attempted to compare recent sediments with ancient. The convening of specialists in the study of recent and old sediments to discuss the geological interpretations of ancient rocks proved to be a very important function of this congress.

The next meeting will be held in Copenhagen, 15–25 Aug., 1960, in connection with the International Geological Congress.

FRANCIS P. SHEPARD
Scripps Institution of Oceanography, La Jolla, California

Vertebrate Speciation

A grant has been made by the National Science Foundation to the University of Texas to assist travel by graduate students to a Conference on Vertebrate Speciation to be held in Austin, Tex., 27–31 October. Persons wishing further information should contact W. Frank Blair, Department of Zoology, University of Texas, Austin 12, Texas.

Insulin in Psychiatry

An International Conference on the Insulin Treatment in Psychiatry has been arranged 24–25 October for the purpose of presenting recent advances in the basic aspects and the clinical uses of Sakel's discovery. The meeting will take place

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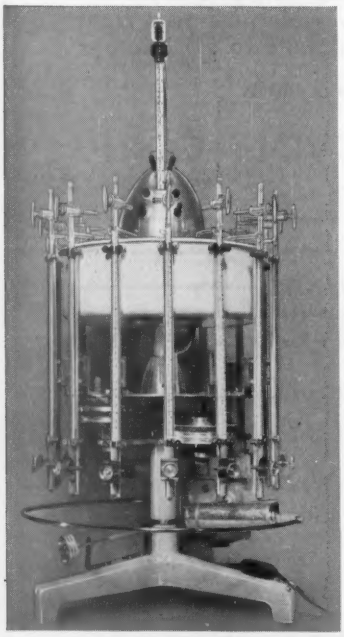

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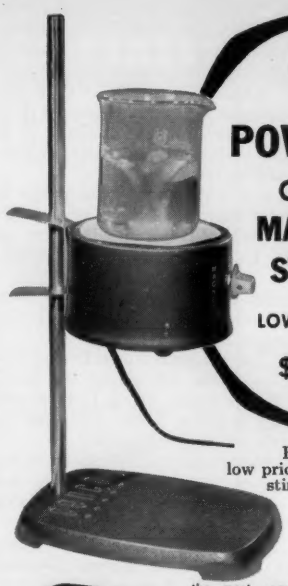

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Forthcoming Events

October

24–25. Taxonomic Consequences of Man's Activities, symp., St. Louis, Mo. (H. C. Cutler, Missouri Botanical Garden, St. Louis.)

30–1. American Assoc. of Textile Chemists and Colorists, 37th natl. conv., Chicago, Ill. (J. G. Kelley, E. I. duPont de Nemours & Co., Inc., 7 South Dearborn St., Chicago 3.)

31–1. Central Soc. for Clinical Research, 31st annual, Chicago, Ill. (A. S. Weisberger, CSCR, Suite 1215, 25 East Washington St., Chicago.)

November

2–7. Radiology, 6th Pan American cong., Lima, Peru. (M. Lesende, Inter-American College of Radiology, Tucuman 1516, Buenos Aires, Argentina.)

3–4. Italian Soc. of Nuclear Biology and Medicine, 3rd cong., Florence, Italy. (Segreteria della Societá Italiana di Biologia e Medicina Nucleare, Clinica Medica, Pisa, Italy.)

4. Use of 650 and 704 Computers for Structure Analysis, conf., Pittsburgh, Pa. (G. A. Jeffrey, Dept. of Chemistry and Physics, Univ. of Pittsburgh, Pittsburgh 13.)

4–7. American Soc. of Tropical Medicine, Miami Beach, Fla. (R. B. Hill, 3575 St. Gaudens Rd., Miami 33.)

4–11. International North Pacific Fisheries Commission, 5th annual (by invitation), Tokyo, Japan. (R. I. Jackson, 209, Wesbrook Building, Univ. of British Columbia, Vancouver 8, Canada.)

5–7. Society for Applied Spectroscopy, annual, New York, N.Y. (P. Lublin, Sylvania Electric Products Inc., Bayside, N.Y.)

5–7. Society of Rheology, annual, Philadelphia, Pa. (W. R. Willets, Titanium Pigment Corp., 99 Hudson St., New York 13.)

6–7. Lead Hygiene Conf., Chicago, Ill. (M. Bowditch, Lead Industries Assoc., 60 E. 42 St., New York, 17.)

6–7. Nuclear Science, 5th annual, San Mateo, Calif. (H. Pratt, IRE, 1 E. 79 St., New York 21.)

6–8. Geochemical Soc., St. Louis, Mo. (K. B. Krauskopf, Geology Dept., Stanford, Calif.)

6–8. Geological Soc. of America, St. Louis, Mo. (H. R. Aldrich, 419 W. 117 St., New York 27.)

6–8. Gerontological Soc., 11th annual scientific meeting, Philadelphia, Pa. (N. W. Shock, Baltimore City Hospitals, Baltimore 24, Md.)

6–8. Paleontological Soc., St. Louis, Mo. (Miss K. V. W. Palmer, 109 Dearborn Pl., Ithaca, New York.)

6–8. Society of Economic Geologists, St. Louis, Mo. (H. M. Bannerman, U.S. Geological Survey, Washington 25, D.C.)

8. Society for the Scientific Study of Sex, 1st annual, New York, N.Y. (R. V. Sherwin, 1 E. 42 St., New York 17.)

8–13. International Rubber Conf., Washington, D.C. (B. S. Garbey, Jr., Pennsalt Chemical Corp., 813 Lancaster Pike, Wayne, Pa.)

10–12. American Petroleum Inst., 38th annual, Chicago, Ill. (API, 50 W. 50 St., New York 20.)

10–12. Physics and Medicine of the Atmosphere and Space, intern. conf. (by invitation), San Antonio, Tex. (Southwest Research Center, 331 Gunter Bldg., San Antonio.)

10–13. American Dental Assoc., Dallas, Tex. (H. Hillenbrand, 222 E. Superior St., Chicago, Ill.)

12–14. Society for Experimental Stress Analysis, annual, Albany, N.Y. (W. W. Murray, P.O. Box 168, Central Square Sta., Cambridge 39, Mass.)

12–15. Society of Naval Architects and Marine Engineers, 66th annual, New York, N.Y. (W. N. Landers, SNAME, 74 Trinity Pl., New York 6.)

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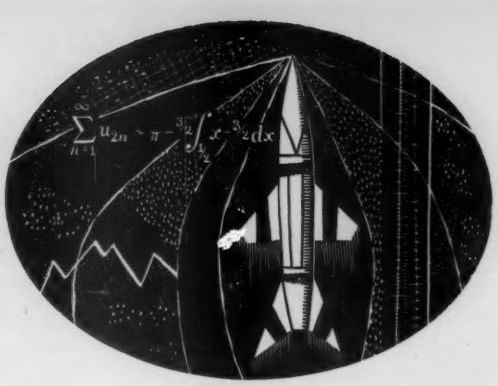

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16–23. Scientific Information, intern. conf., Washington, D.C. (Mrs. M. Sheppard, Intern. Conf. on Scientific Information, Natl. Acad. of Sciences–Natl. Research Council, 2101 Constitution Ave., Washington 25.)

17–20. Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. (H. B. Callen, Dept. of Physics, Univ. of Pennsylvania, Philadelphia.)

18–20. Air Pollution, 1st natl. conf., Washington, D.C. (Dept. of Health, Education, and Welfare, U.S. Public Health Service. Washington 25.)

(*See issue of 19 September for comprehensive list*)

Letters

Radioactive Wrist Watches

J. L. Haybittle, of the Radiotherapeutic Center at Addenbrooke's Hospital in Cambridge, England, has reported in *Nature* (17 May 1958) that some luminous-dial wrist watches contain sufficient radium to subject their owners to nearly two-thirds the maximum permissible level for exposure of hands and forearms. According to Haybittle, one watch, having an estimated radium content of 2.2 μc, recorded on a film placed in contact with the back of the watch a dose rate of 8 mr/hr.

During the past year we have been investigating the degree of radioactivity of luminous-dial wrist watches as these were made available to us by their owners. Watches were found to vary more than tenfold in their activity. Of 20 watches examined, 12 showed activity not exceeding 1 mr/hr at a distance of approximately 1 in. from the face of the watch, four registered between 1 and 5 mr/hr, two between 5 and 8 mr/hr, and two between 8 and 10 mr/hr.

With an activity of 8 mr/hr at a distance of 1 in., it may be calculated that at a distance of 8 in. a wrist watch worn 24 hours a day can deliver 1.1 r a year; this is the dosage that might be delivered to the gonads by the most active watches when the watch is worn on the wrist in a position facing the gonads. The least active watches could deliver approximately one-tenth this activity, or 110 mr/yr (at 8 in.); at 12 in. this would be reduced to about 49 mr/yr, in good agreement with the dosage of 40 mr/yr estimated by Libby in *Science* [**122**, 57 (1955)] for a wrist-watch radiation source at an average distance of 12 in. from the central body, including sex organs. The potentially harmful magnitude of the radiation from the most active watches, corresponding to 5 rem in about 5 years, may be judged in the light of the recommendation by the International Commission on Radiation Protection that no one should receive a dose in excess of 5 rem by age 30.

When one further considers that this radiation is several times greater than natural background radiation and exceeds by more than 100 times that presently received from radioactive fallout, the potential hazard to the wearer of a luminous-dial wrist watch raises the question as to whether the small benefit that may be received from such a watch is worth the hazard.

GRAFTON D. CHASE
ARTHUR OSOL
School of Chemistry, Philadelphia College of Pharmacy and Science, Philadelphia, Pennsylvania

Drug Synergism

In the report entitled "Drug synergism (potentiation) in pain relief in man: papaverine and morphine," by Macris, Gravenstein, Reichle, and Beecher [*Science* **128**, 84 (1958)], the authors found "that less pain relief is obtained from morphine not preceded by papaverine." In their interpretation of this finding the authors conclude that "synergism in the relief of pathological pain has been clearly demonstrated with analgesic drugs." The authors also point out that papaverine alone has no analgesic power.

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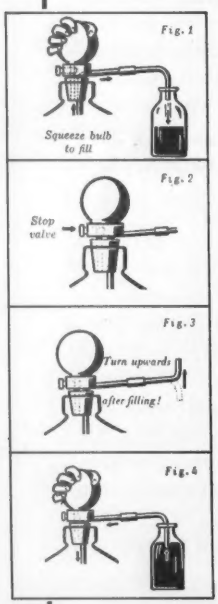

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According to the methods described or referred to as having been employed in this study, it would appear that some patients in a group of 18 received a chemically effective analgesic (morphine) soon after surgery whereas the remainder of the group did not receive this treatment until at least 2 hours later, after they first had been given an ineffective treatment (papaverine). If this is so, it is possible to explain the results that were obtained on the basis of (i) differences in the duration of pain before chemically effective analgesia or (ii) the influence of prior experience with the ineffective papaverine treatment upon subjective reactions to morphine. Neither of these explanations implies drug synergy. That is, it is possible that the patients whose pain remained untreated for the longer period simply appreciated eventual treatment to a greater extent and, consequently, judged the treatment to be more effective. Or, by comparison with an ineffective treatment, the perceived effects of an active treatment may have been enhanced over those perceived without any reference.

It might be argued that these alternative interpretations of the findings in this study are less plausible than the synergy explanation offered by the authors. However, it would seem that the very existence of alternative explanations that are consistent with the literature on subjective measurement raises an appreciable doubt that, in this study, pharmacologic synergy" has been clearly demonstrated."

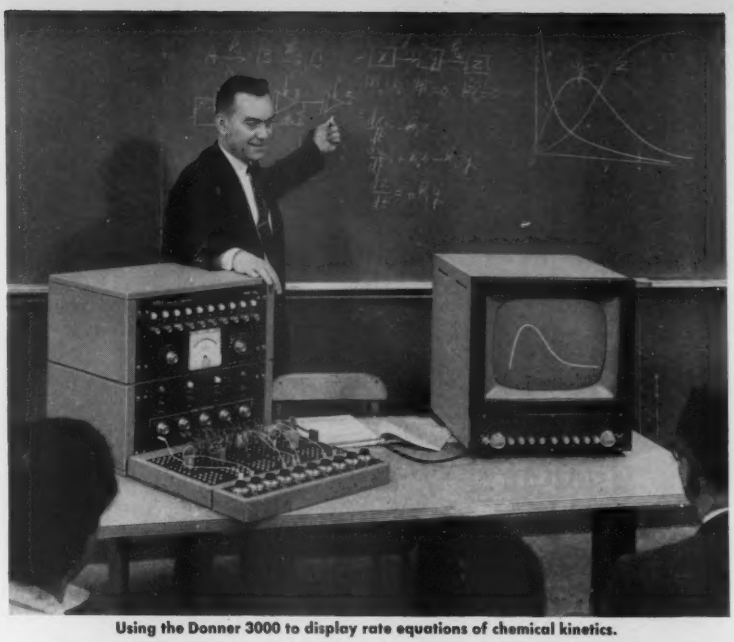
RICHARD M. RITTER

San Antonio, Texas

In clarifying the situation, points to emphasize are the following: (i) patients do not know what they are getting; (ii) the order of drug administration is randomized; (iii) papaverine itself is equally ineffective as an analgesic whether it follows or precedes morphine. This could hardly be so if Ritter's argument is correct. In view of this we do not believe that Ritter's points (i) and (ii) have validity, although we have of course discussed such an "explanation" over the years. Evidence is lacking here that a subsequent dose is significantly influenced by the fact of a single postoperative medication. If this is not the case, we must have better grounds for giving up this positive evidence than Ritter's vague reference to the "literature on subjective measurement." I am familiar with this literature, having just completed a long book on the *Measurement of Subjective Responses* with over 1000 references, but I do not know what Ritter refers to. As we said in the report, "No clue about the nature of this interaction is available."

HENRY K. BEECHER

Department of Anaesthesia, Massachusetts General Hospital, Boston



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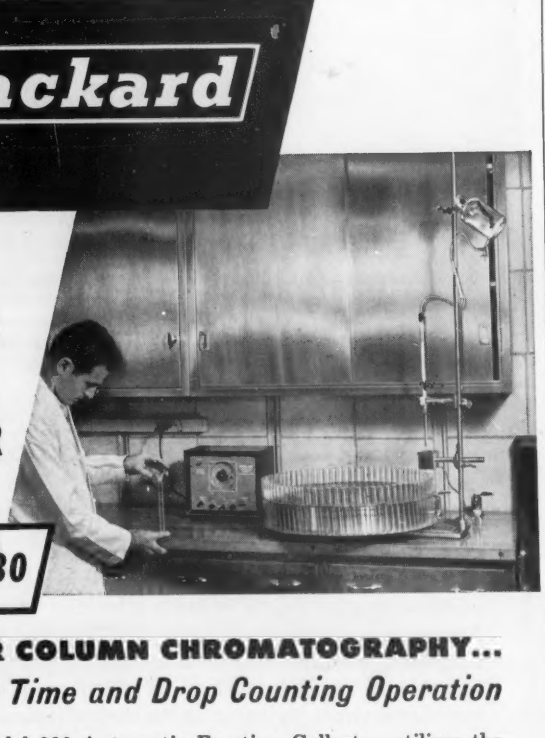

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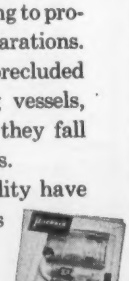

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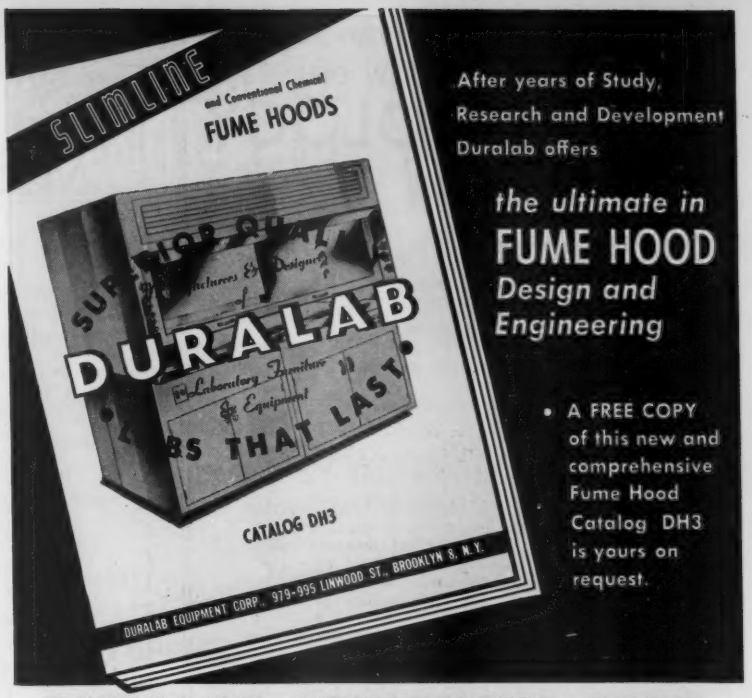
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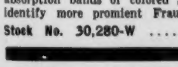

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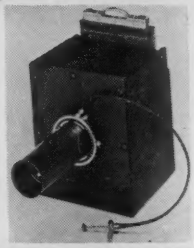

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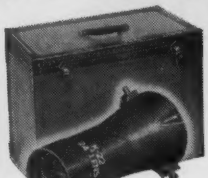

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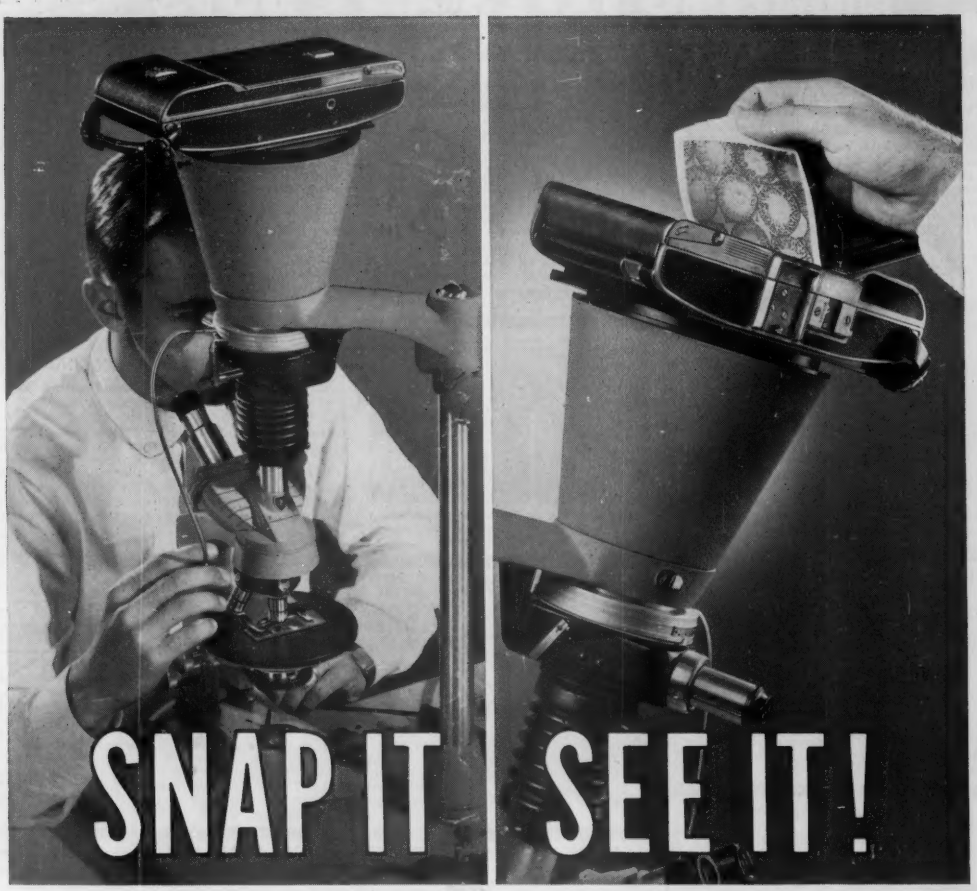

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